# General Psychology

*by*

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DEDICATED TO THE MEMORY

OF MY FRIEND AND COLLEAGUE

ALBERT P. WEISS

# Preface to Revised Edition

IT HAS been our purpose to render the revised edition more acceptable to the beginning student without the sacrifice of the essential facts of general psychology. To this end we have subdivided the long chapters into shorter ones, which in turn have been grouped into sections. Many illustrations selected from concrete experiences of students in everyday situations have been added in the hope that this material will render psychology more functional in the lives of the students.

The point of view has not been greatly changed. The objective method is emphasized throughout in the endeavor to direct the student toward a scientific attitude with reference to human behavior. Greater emphasis has been given to the growing recognition of the importance of configuration without the adoption of an extreme Gestalt viewpoint.

I am again indebted to my associates for many constructive suggestions: especially to Dr. W. L. Valentine, who has prepared a student's guide of laboratory and classroom exercises which are listed in this text; to Dr. K. H. Baker, who has supplied the questions for review at the end of each chapter and also revised the index; and to Dr. F. N. Stanton, who has contributed the additional illustrations and revised several of the earlier ones. Dr. L. H. Lanier, of Vanderbilt University, has offered many helpful criticisms which have been adopted in the revision.

F. C. D.

# Preface to First Edition

THE late Professor Weiss urged a conception of psychology based on the development of the infant into an adult in a coöperative human society—a genetic viewpoint that has been adopted in this book. For this reason, considerable emphasis has been placed upon the nature of the human organism and its place in the phylogenetic series, to the stimulus-response mechanisms, and to the modifications of behavior of the individual in making adequate adjustment to his physical and social environment. While the environmental factors in shaping behavior have received a prominent place, the author has attempted constantly to stress the importance of the individual as a prominent factor in determining his behavior. Man's superiority over the other animals lies in the greater modifiability of his behavior and in its extreme variability. Biologically, this fact is expressed in his gross bodily structures, such as the hands and speech mechanisms, and by the enormous overgrowth of the cerebral hemispheres.

It is generally accepted by psychologists that the older psychology must be discarded. Yet too frequently we are guilty of confirming in the minds of beginning students the popular belief that instinct, emotion, attention, memory, and so forth are discrete elements. So far as possible the author has in his present text avoided these terms or carefully defined them in terms of the behavior of the total organism. It is for this reason that emotion has been described as disorganized response and attention

as organized response. It has not been his intention to propose any new theory in such cases, but merely to describe what seems to be the type of behavior generally included under each category. For example, emotion is generally described as excitement or confusion; attention is described as concentration, focal point, clearness, or adjustment. It would facilitate the description of human behavior if we could avoid the old terminology entirely, but unfortunately these literary terms are too definitely fixed in the language of our students, and they must have an explanation of the terms they have already learned.

Finally, the interests of the general student must be taken into account. It is not the author's aim to train professional psychologists. As a matter of fact, only a few of the first-year students ever even continue in advanced courses. It is this large group who will never again come into contact with systematic psychology that the author hopes to make cognizant of psychological problems that cannot be escaped in the social adjustments in and out of college. If he can engender an objective viewpoint with regard to these complex relationships, the author will be well pleased. In addition to these relatively personal objectives there has been an implicit attempt to develop an appreciation of the problems of the professional psychologist.

The author is indebted to his colleagues in the department for many helpful criticisms and suggestions. For three years a corps of twenty instructors ranging from professors of the regular staff to part-time instructors have used the text in its preliminary forms. Chapters have been shifted, and material has been added or eliminated on the basis of the experience of these teachers. The author is especially indebted to Dr. W. L. Valentine, who, as associate director of the beginning course, has

been most intimately associated with the writing of the book. He has also prepared the laboratory manual to which references are made throughout this text. Dr. W. C. Beasley supplied a part of the material of Chapters XX and XXI and furnished several drawings. Dr. F. N. Maxfield made many suggestions embodied in Section X and suggested the title, "Levels of Attainment." Dr. Helen Morrill Wolfle read large portions of the manuscript and criticized the literary form. The author is finally indebted to Mr. F. N. Stanton for drawing most of the illustrations and to Miss Dorothy Rose Disher for compiling the index.

F. C. D.

# Acknowledgments

THE author is very grateful to the publishers and authors who have so kindly permitted him to borrow illustrations from their texts. The following is a list of figures in this text which were borrowed and the publishers from whose books they were taken:

D. Appleton and Company, Figure 39, from Poffenberger's *Applied Psychology*; Figure 40, from Cannon's *Bodily Changes in Pain, Hunger, Fear and Rage*; Figures 82 and 83, from Pintner and Paterson's *A Scale of Performance Tests*.

P. Blakiston's Son and Company, Incorporated, Figure 9, from Morris' *Human Anatomy*.

Ginn and Company, Figure 16, from Hough and Sedgwick's *The Human Mechanism*.

Harcourt, Brace and Company, Figures 71 and 72, from Köhler's *Mentality of Apes*.

Harper and Brothers, Figure 54, from Valentine's *Readings in Experimental Psychology*.

Henry Holt and Company, Figure 66, from Woodworth's *Psychology*, third edition. Adapted from Tolman and Honzik, *University of California Publications*, Vol. IV, 17.

Houghton Mifflin Company, Figure 79, from Terman's *Measurement of Intelligence*; and Figure 89, from Allport's *Social Psychology*.

The Macmillan Company, Figures 22, 23, and 24, from Coghill's *Anatomy and the Problem of Behavior*; Figure 35, from Titchener's *Textbook of Psychology*; Figures 55 and 57, from Miller's *Science of Musical Sounds*; and Figure 69, from Thorndike's *Adult Learning*.

McGraw-Hill Book Company, Figure 21, from *Electronics*.

W. W. Norton and Company, Incorporated, Figure 15, from Adrian's *Basis of Sensation.*

W. B. Saunders Company, Figure 19, from Howell's *Human Physiology.*

*Scientific Monthly,* Figures 6 and 7.

C. H. Stoelting Company, Figures 2, 36, 43, 50, 51, and 58.

Taylor Instrument Company, Figure 41.

University of Chicago Press, Figures 90, 91, and 92, from Thurstone and Chave's *Measurement of Attitudes.*

*University of Iowa Monographs,* Figure 84, from Seashore's *Vocational Guidance in Music.*

D. Van Nostrand Company, Figure 56, from Fletcher's *Speech and Hearing.*

William Wood and Company, Figure 17, from Cunningham's *Anatomy.*

The following figures have been borrowed from psychological journals: *American Journal of Psychology,* Figure 70; *Archives of Psychology,* Figure 26; *Behavior Monographs,* Figure 74; *Comparative Psychology Monographs,* Figure 27; *Journal of Abnormal and Social Psychology,* Figure 94; *Journal of Animal Behavior,* Figure 62; *Journal of Comparative Psychology,* Figures 28 and 81; *Journal of Educational Psychology,* Figure 68; *Journal of General Psychology,* Figure 65; *Journal of Genetic Psychology,* Figures 59 and 60; *Psychological Monographs,* Figures 37, 64, and 77; *Psychological Review,* Figure 67; and *Psychological Review Monograph Supplement,* Figure 61.

# Contents

INTRODUCTION

# How to Study

WHEN a student begins a new course, he is setting up a project in which he presumably intends to make an investment of time and energy. How much this investment will yield for him will depend upon how well his time and energy are expended. Some students acquire a great deal with a small expenditure, while others make their investment unwisely and either gain no satisfaction or pay too dearly for what they get. It is the purpose of this brief chapter to point out some factors which should be helpful to the student.

**Survey the course.** It is always essential to seek a general orientation with regard to the course as a whole, to know in what direction it is leading, and to be sure that you are headed in that direction. Frequently students say: "I didn't know this would be expected," or, near the end of the course, "I am just beginning to see what it is all about." A great deal of labor and confusion can be saved if you get started on the right path at the beginning. The instructor usually gives a preview of the course on the first day. If for some good reason your instructor does not do this, or if you are absent the first day, make a general survey of the textbook, reading chapter and paragraph headings. Consult the index and follow up some of the topics that catch your eye.

**Follow the instructor.** It is important to find out early what the instructor expects from you. Remember

that he is not a taskmaster. He has set up in the course specific objectives the fulfillment of which he reali will be to the best interests of your progress. You feel that not all of these objectives are pertinent t case. In that event you should take cognizance of the fact that you are not the only student in the class, and that, although your instructor will make every effort to individualize his instruction, you finally are responsible for getting out of the course a satisfaction of your own aims. The instructor's objectives in the course may include those described below, though he may have others and though he may place greater emphasis on some than on others. If he does not make clear to you just what his objectives are, you should ask him at the first opportunity. Another method is to follow closely the instructor's procedure to note what he emphasizes and to infer what his fundamental purposes are.

## General Objectives

**Facts and principles.** In any course it is of prime importance to gain a knowledge of the subject matter. It is always essential to master the facts. Frequently students complain that they do not want to be crammed with facts, but want to be trained to think. Thinking cannot develop out of thin air. You must have tools with which to think, and facts are the tools. It is necessary, therefore, to give careful attention to details and to understand and to catalog the facts. One item of learning of this type comprises the technical vocabulary. A large proportion of failures is due to a lack of understanding of the technical terms used.

On the basis of the innumerable facts presented in the course, we may formulate generalizations or evolve prin-

ciples. You should do this yourself, for this is where ı get your opportunity for training in clear thinking. - remembers detailed or isolated facts readily; but one has evolved a principle that expresses these facts, he is not so likely to forget this principle. We may read that 6.8 per cent of full-blood Indians scored above the average white man on an intelligence test, and that 9.1 per cent of the three-quarter-blood, 18.4 per cent of the half-blood, and 27.7 per cent of the quarter-blood Indians scored above the average; but these figures will soon be forgotten. If you formulate the generalization that the per cent of superior Indians increases as the degree of Indian blood decreases, you are not so likely to forget that.

**The application of principles.** It is frequently observed that an educated person is impractical, that he is not able to apply to everyday situations the facts and principles which he has learned. This deficiency is due in part to the way in which the facts and principles have been presented and in part to the fact that the student has not appreciated that the material had any functional value. In a course in psychology, for example, you should attempt to use every principle that you develop, first, for assistance in interpreting later material in the course, and second, for understanding your own conduct. It is only when you practise applying these principles in your own life that they will attain any value for you. It is too often true that the student assumes that these principles must concern some other person or some mythical being, and not himself.

## Effective Study Habits

**Learning to read.** In general, the more rapid reader gets more out of what he reads. This is due, in part, to the fact that facility in reading affords a greater opportunity to master what is read. Reading requires a series of eye fixations and eye movements, as well as a piecing together of words and phrases and an understanding of their meaning. The rapid reader usually has little difficulty in fixations and movements, and is therefore free to give greater attention to the subject matter. He is also more able to view the material as a whole, whereas the slow reader is inclined to deal with such small sections of the material at a time that he loses sight of the total structure. You would do well to examine your own habits of reading. Observe the number of pages of an ordinary book which you can read in an hour. Some read less than twenty-five pages, while others read a hundred pages or more.

Rapidity, however, is not the only requirement for efficient reading. Students frequently remark: "I do not see why I am not doing better. I read over each assignment twice." Intelligent reading requires more than "reading over" the text. You must learn to read critically. What are the important facts stated in the paragraph? What is the basis for this interpretation? You must learn to understand, analyze, and evaluate as you read. Do not skip tables and graphs. They are inserted in a text because they are important for understanding the discussion. Always check the data given in the table against the discussion to see how well it supports the argument. There are several kinds of graphs: bar graphs, line graphs, and graphs to show rate of learning,

distribution of scores, and the relationship between two variables. These graphs are intended to give a unified picture of the data and should be helpful in a determination of the principles evolved from the data. Finally, you must read with a view to remembering what you have read.

In reading a textbook on psychology, you may find that a great deal of it seems very familiar to you. This fact may be your greatest difficulty because you fail to recognize the import of the author's discussion. Doubtless you could write an essay on motivation, emotion, instinct, memory, or reasoning; but would this be a psychological treatise? You will find that it will be necessary to alter your habits of reading and thinking as the course progresses.

**Active listening.** The classroom furnishes an opportunity for gaining new light on the material of the textbook, for the exchange of opinions, and for the supplying of supplementary material by the instructor. It is not a place to loaf. Too many students go to class because it is a requirement to be endured. The fact that they are present is all that is expected of them, unless they are called upon. This attitude generates a bad habit of passivity which is often more detrimental than cutting the class.

Give careful attention to everything that occurs in the classroom. If a student is attempting to answer a question, listen attentively and evaluate his statement. If a student asks what seems to you a stupid question, note how the instructor deals with it. Many times the "stupid" question or comment brings out the most important point of the hour. If the instructor is lecturing, remember that he has spent a great deal of time, more than you realize, in order to give you important material.

Many times a question arises and a student waves his hand or otherwise seeks to interrupt the instructor's discourse. This is not only discourteous, but the student misses the importance of what the instructor is saying. His own question may even be answered in what follows, but he may not recognize it because of his own insistence upon getting the floor to speak.

**Distribution of time.** You have more than one course and many other activities which will demand a part of your time. For the most satisfactory results, your time should be budgeted just as your money should be. Do your studying at regular, specified intervals. Experiments have universally shown that more is accomplished by the proper distribution of the time of study than by cramming. It will take less total time and it will result in the material's being better understood and remembered longer.

Closely related to day-by-day study habits is the close association of your studies with your other daily activities. College life makes many demands upon the student. Too often, therefore, the subjects that he is studying are completely laid aside the moment the books are closed. Athletics, movies, and dances are the topics of conversation. If you can manage to discuss the material of your courses with a fellow student, you will both be benefited, even though your discussion takes on a lighter strain.

**Examinations.** If you follow the suggestions already proposed, it will not be necessary for you to study for the examination. A brief review is all that will be necessary. The examination should be set up by the instructor to determine how well you have attained the objectives of the course. Your best rule will be to do your studying early and to rest before the examination so that you will have a clear head. An examination is like a football

game. Just as the team ceases severe training and indulges in only light practice before the game, you should proceed to master the course throughout the term and indulge in only general review immediately preceding the examination.

**Teaching and learning.** How successful you are in the mastery of the course will depend upon how well you make your investment. The instructor can select the material and organize the course; he can offer suggestions and criticisms which point the way for you, but he cannot teach you. Mastery of any subject depends upon the effort you expend and upon how efficiently it is expended. Some general suggestions have been given in this chapter in the hope that they may be helpful to you in the organization of your efforts. No specific rules are given because each student must discover for himself the specific methods which are best adapted to his needs. There is no royal road to mastery, but the way may be made easier by the development of efficient study habits.

# BOOK I

## SECTION I—THE SCIENTIFIC POINT OF VIEW



References to Student's Guide:*

Exercise 1. Commonly Believed Propositions Regarding Behavior
Exercise 2. Check List of Behavior Items
Exercise 3. Discussion Questions
Exercise 4. Identifying Psychological Problems
Exercise 5. Check List of Terminology and Understanding
Exercise 6. A Class Shopping Experiment
Exercise 7. Objective Observation of One's Own Behavior
Exercise 8. Blond and Brunet Traits
Exercise 9. Planning a Scientific Experiment
Exercise 11. Reaction Time
Exercise 14. The Minnesota Rate of Manipulation Test

* Valentine, W. L., Taylor, J. H., Baker, K. H., and Stanton, F. N., *Student's Guide,* New York, Prentice-Hall, Inc., 1935.

## CHAPTER I

# The Problem of Psychology

Psychology is that branch of science which studies, and attempts to formulate, the laws of human behavior. It is interested in the problem of how man gets along in a physical world; how he copes with the situations of his physical environment, protects himself from the harmful elements, and secures food; and, more especially, how he gets along in his social world, for man is above all else a social animal. He has developed a social organization which is so complex that we frequently fail to recognize that he is an animal, in many respects not unlike the ape, the monkey, and even the still lower species.

This social development of man brings with it many problems. It is the realization of these problems that has led to the great popular interest in psychology at present. We realize that some men are more intelligent than others, and that generally, although not always, the more intelligent are farther up the scale of success. The less intelligent may depend for their success upon money, beauty, or social prestige, or may have learned how to behave in the presence of others.

It is generally true that we all "pose" to some extent. No one knows us as we really are. We say we are using diplomacy, or that we are making social adjustments. This task of making social adjustments, getting along with others, making our own lives most effective in society, and selecting the work for which we are best fitted

is the individual's big problem. Some individuals break under the strain, and we call them "criminals," "insane," or "maladjusted," according to the behavior they manifest.

**The aims of psychology.** At the present time, all the questions we should like answered cannot be answered by psychology, but it is the business of psychology to investigate them. We may catalogue some of the principal aims for the study of psychology as follows:

1. To learn the principles and laws that govern human behavior.

2. To enable the individual, through a better understanding of himself:
   *a.* To build up socially acceptable modes of behavior.
   *b.* To eliminate behavior that is not approved.
   *c.* To take the greatest advantage of his potentialities.

3. To enable the individual to predict and control the behavior of others, as well as his own; also to enable him to appreciate the attitudes and behavior of those whose codes are different from his.

4. To develop a scientific attitude toward human behavior that will eliminate prejudice, superstition, and reliance upon beliefs ungrounded in facts.

**Psychological material.** Broadly speaking, we may say that wherever there are human relations, there is the opportunity for the scientific study of psychology. To state the same thing in another way, wherever we have an individual reacting to a situation, whether this situation is the physical environment in which he lives or another individual or a group of individuals with whom he must get along, there arise specific problems which the psychologist might investigate. This does not mean

that every account of human behavior is psychology or constitutes a psychological treatise. Some accounts are purely literary, for example, the portrayals of the poet or novelist; while others are historical or biographical.

**Literary versus scientific description.** The literary accounts attempt to formulate in verbal terms the ideals, emotions, and desires of man; to interpret life in a fashion that will satisfy the author's belief as to what man's life is. The psychologist must examine and analyze the mechanisms of human conduct and discover the nature of man's emotions, desires, and thinking. If his preconceived notions as to human nature are proved to be false, then he must revise these notions to fit the facts discovered.

**History and psychology.** History is a study of the events befalling peoples, of the movements of groups or nations. As such, it is not psychology, but the recording of movements of society as a whole. The historian wishes to know what influenced a certain movement, what were the motives that led to the formulation of the Constitution of the United States, for example. He finds that the Colonies had experienced certain conflicts with the British government, that the courts, import duties, imprisonment for debts, and freedom of religious worship were in the immediate background. Other less obvious reasons were equally important. The historian may look for the motives that have contributed to a certain movement. The psychologist investigates the *origin* and *nature* of motives in the individual.

**Popular and scientific psychology.** An error often made by the layman is the assumption that he is a psychologist because he is dealing with human relations and must of necessity make certain observations of human conduct. He does not consider himself a physiologist

because he selects certain foods which supply his needs and avoids others because they do not agree with him. Neither does he pretend to be a physicist when he makes use of a lever to move a heavy object. Experience has taught him that certain foods are harmful, and he has learned that a heavy object may be moved by the proper use of an iron bar; but that is all there is to it. It does not mean that he has investigated the processes involved in digestion or, necessarily, that he understands the laws of mechanics.

His psychology is of the same sort. He knows, perhaps, that there are certain good methods of approach to be used for gaining the good will of another individual; but this does not imply that he understands even the most elementary laws of human behavior.

The foregoing criticism need not suggest, however, that the layman lacks an interest in scientific psychology, or that he cannot make use of the facts when they are presented to him. What is indicated is that his unguided interest makes him a victim of fakers who have mixed a few facts with a mass of superficial statements in convincing language which the uninitiated accepts as truth. Thus, he is frequently led to believe that psychology is simply and easily understood without study, and that scientific data in the field are relatively unimportant.

Business men, preachers, doctors, social workers, and a host of others have not only read and accepted absurd theories of the mental life and personality, but have frequently based writings on such theories. These works are often stimulating, but they should be classed as such and not confused with scientific data and method.

**Terminology versus understanding.** One of the difficulties in the way of a clear understanding of human behavior is the frequent assumption that when we have

assigned a name to an event, we have thereby described and explained the phenomenon in question. For example, a certain student coming from a respectable family and provided with a liberal allowance persistently stole things she could not use—such as dresses, jewelry, traveling bags, and money—packing it all into a closet. This behavior is called *kleptomania.* But this term merely signifies that this person persistently steals. *Why* does she steal? *What* are the circumstances that have led to this type of behavior that we call kleptomania? Giving the behavior a name has not explained it.

Investigation shows that when the student we have mentioned was twelve years old, she was worried by the tales told her by an older girl who frequently stole for financial gain. In her most perplexed moments she imitated the older girl by stealing. This behavior became closely linked with her worries, so that now she cannot resist stealing whenever she is worried, just as one may develop the habit of lighting another cigarette, or of tapping with his fingers, every time he is perplexed.

Likewise, we may say that a person's behavior is due to *morbid curiosity;* but here again we are merely naming the behavior and are not describing or interpreting it. One person may pick up the newspaper and read the headlines; another may turn to the financial reports, the sports page, or the comics. Each manifests behavior which we may classify under the head of curiosity. It would be more difficult to say what we mean by *morbid* curiosity.

Ten thousand people crowd about the little chapel where the funeral service for a little child who was murdered is being conducted. Throngs gather to see the body of a notorious bandit who has been slain. To say that such behavior is due to morbid curiosity is in no way

to explain it. In fact, this type of behavior has not yet been thoroughly investigated and interpreted.

We frequently hear it said that so-and-so's behavior is due to an *inferiority complex.* It may be that the person in question keeps in the background; that he hesitates to voice his own opinion; or that he blushes easily. On the other hand, another person talks on all occasions: he shoulders his way to the front. Both types of behavior are often "explained" by the statement that they are manifestations of an inferiority complex. Can it be true that both the submissive and the aggressive types of behavior may be *explained* by the same term? The fact is that they are not explained by the term at all.

Let us take a specific example. A certain student was restless in class; he scoffed at most of the interpretations proposed by other students and by the instructor; he talked in a blustering manner but did poorly in his own work. After several interviews with him in which the instructor attempted to discover the cause of this behavior, it was revealed that as a boy this student had never gotten along well with his father, who was dominating and often cruel. Finally, he left home, but soon ran amuck in the hands of the police. Now, after two years, he was back in college trying to make a new start. This description of his experiences explains his present behavior. These data comprise what we mean by "inferiority complex" in this particular case.

**Description and explanation.** We have shown in the preceding pages that naming a bit of behavior does not describe or explain it. Naming a phenomenon may be sufficient for some nonscientific purposes; but as an explanation, mere naming is inadequate—in fact, from a scientific point of view, it is a vicious error. Thus, to say that persistent stealing is kleptomania is not to explain

it at all, while to say that certain behavior is due to an inferiority complex is to tell us nothing about the causes or circumstances that led to the behavior that is to be explained.

A three-year-old child asks, "What makes the engine go?" He is satisfied when he is told that the man puts coal in it to make it go. Later this simple explanation is not enough, and he must be told that the energy stored in the coal is released as heat by the process of combustion, that this heat is transferred to the water, which expands into steam, and that finally the energy is transferred to the pistons, and so forth. A series of events has then been described, but it is called *explaining*. For most adults, this explanation of the steam engine would be sufficient; but it is incomplete. How did the energy get into the coal? Why does heat make water expand?

We see, then, that an explanation is description of other events, and that any explanation is never final. We explain an event not by assigning a name to it, but by describing preceding events; and these events, in turn, need to be described in greater and greater detail.

**Dangers in names.** There are two reasons why the substitution of names for descriptive explanations is dangerous. In the first place, when we attach a name to behavior, we are likely to forget what the name really should signify, or to forget that we have not completed our explanation. This practice of explaining by classifying is sometimes called "finished psychology." It really should be designated "unfinished psychology," because the description, as an explanation, is incomplete and faulty.

Frequently, when a student has been considering the behavior of a monkey and a human subject as each solves a puzzle, he will say that the monkey solved the puzzle

by using instinct while the human subject used his mind. The student is satisfied: he thinks he has finished his explanation, although really he has not *explained* the behavior of his two subjects by using such terms as *instinct* and *mind*.

In the second place, names become things. That is, they represent behavior phenomena as existing in and of themselves. For example, we have used such terms as *instinct, consciousness, mind,* and *will* as explanatory principles so frequently that it is difficult to appreciate that they are not discrete entities unrelated to the rest of the individual's behavior. We say that Mr. *A* has a strong will, or that Mr. *B* has a weak will, as though this were something that resided inside the body but entirely independent of the individual's other modes of behavior.

There was a time when man observed the clouds and the storm and said that a person not unlike himself was behind the cloud and caused the storm. Today we recognize at least the more immediate physical forces involved in the weather and can predict weather conditions with considerable accuracy. While we have thus given up the "man-behind-the-cloud" concept with regard to our physical world, we still cling to the old belief of a "man within," a mind, consciousness, or sub-consciousness, which is in some manner independent of the physical organism.

It is not our purpose at this point to deny mind or consciousness, but merely to point out that the popular beliefs, based on facts no more adequate than those that substantiated the beliefs regarding the physical world, have persisted and have consequently delayed the advancement of our knowledge of human behavior, or of our "mental life," if one prefers that term.

We shall show that the individual and his mind cannot

be separated. We shall see that *thinking, believing, willing, attending,* and the like are governed just as definitely by law as are any other natural phenomena. It will also become apparent that though reference to *mind, mental activity,* or *consciousness* as an explanation of observed phenomena is justifiable in ordinary speech, these terms must also be explained.

We frequently hear such expressions as: "By a conscious effort, I performed my task"; "He is intelligent, but lacks personality"; "He instinctively thought of the right answer." The student of psychology cannot make such statements without going back each time to the examination of the various factors which have worked together to bring about the behavior under consideration.

## Questions for Review

1. What four aims for the study of psychology are given in this chapter? What other reasons of your own can you add?

2. Point out the differences in the accounts of human behavior given by the novelist, the historian, the economist, the political scientist, and the psychologist.

3. Distinguish between the poet's and the psychologist's treatment of human nature.

4. Of what does an adequate description consist? Give an example.

5. What are two of the dangers inherent in the use of names as explanations?

6. Observe carefully and list how many times in one day you hear a name used as an explanation. Is it true that these explanations occur because of the absence of adequate information regarding the subject being discussed?

## References

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Weiss, A. P., "Foreword" in *Readings in Experimental Psychology* (W. L. Valentine, ed.), New York, Harper's, 1931, pp. ix–xi.

CHAPTER II

# Scientific Method in Psychology[1]

**Definition of psychology.** Since the time of Aristotle (385–322 B.C.), psychology has been accepted as the study of the adjustment of the individual to his environment. Aristotle did not invent the term *psychology,* for it was not until the sixteenth century that Melanchthon, a German philosopher, introduced it. Because of the theological influence of Melanchthon's time, psychology signified to him the study of the soul (*psyche*). This notion in one form or another has persisted until fairly recent times. Tradition has established the name, and there seems no good reason why any attempt should be made to change it, though we need not limit our investigation to any assumption of the place of the soul or mind in our study.

It is enough that the modern psychologist is interested in a variety of problems affecting the relation of the individual to his environment, and that the emphasis is placed upon his conduct, or how he deals with the situations that present themselves. The modern psychologist considers the human individual a living organism influenced by light, heat, and other forces in his physical environment, whose conduct is further modified by other organisms, particularly other human organisms, his social

[1] A motion picture film, "A Trip Through the Psychology Laboratory," illustrating many of the features of this chapter, has been prepared by Dr. W. L. Valentine at Ohio State University.

environment, and who in turn acts upon his environment to modify it.

**Relation of psychology to other sciences.** All sciences are relatively interdependent. In fact, it would be more correct to speak of one science subdivided for convenience into the numerous branches, for natural phenomena are continuous. The botanist may be dealing with living protoplasm in the form of plants, but this protoplasm is constituted of physical and chemical elements and obeys the same laws as apply to other forms of matter. For this reason the botanist cannot neglect the findings of physics and chemistry. Physics, likewise, is related to chemistry, biology, geology, and so forth.

The accompanying figure (Figure 1) illustrates some of these overlappings of the so-called sciences. We may

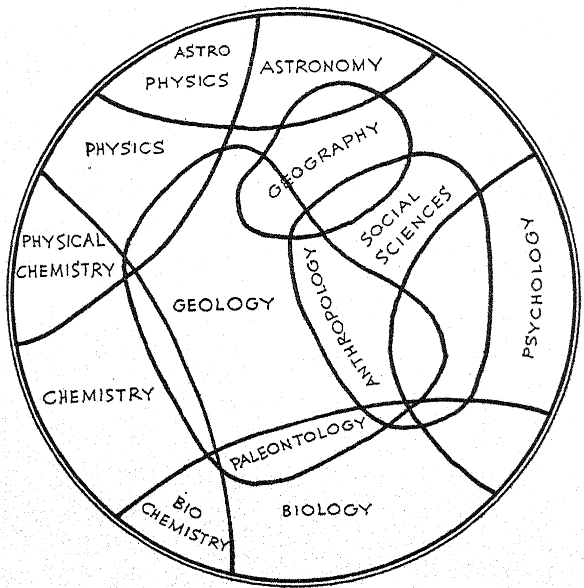


Figure 1.—The "Sphere" of Science.

more properly speak of them as belonging to the "sphere of science." Thus, physical chemistry embodies both physics and chemistry; geography, in addition to its immediate subject matter, draws from, and contributes to, astronomy, geology, anthropology, and the social sciences; psychology overlaps with biology (comparative psychology) and the social sciences (social psychology), as well as more indirectly with the other branches of science. Not all of the interrelationships are shown here, but enough are given to make it clear that science embraces the whole body of knowledge regardless of the specific subject matter under investigation. What distinguishes science is its method.

**The method of science.** The chief factor in the scientific method is its requirement that the observer be trained to distinguish what he observes from what he would like to infer. The observer's prejudices or preconceived notions must be kept out of the investigation. The difference between the truly trained scientist and the untrained observer is that the former is more able to exclude his prejudices. The investigator must be intimately acquainted with like phenomena in the same and related fields, and must secure the facts which preceded the phenomena under present observation.

It is sometimes true that an investigator, particularly a physicist, assumes that the fineness of discrimination or the minuteness of the units of his measures is the distinguishing qualification of the scientific method. This is not, however, the essential characteristic of science. The unit of measurement will vary with the material under investigation, but the proper attitude on the part of the investigator is always necessary. With the unscientific investigator, often the interpretation far exceeds the data actually observed, part of the data are neglected,

or various facts relevant to the present observation are not considered.

**Observation and inference.** Let us examine an instance of what we have just stated regarding the requirement of scientific observation. Two students were instructed to visit a department store and pretend to be shopping for a coat. They were to observe carefully the behavior of the clerk and write a detailed report of their experiences. One of the reports contained the following: (1) "I asked for a certain clerk to whom I had been referred, but was told she had left." (2) "The one who waited on me was certainly not cut out to be a saleslady." (3) "I told her what I wanted, but she brought me something else." (4) "She contradicted me several times." (5) "So I left."

The other student, who was a witness to the transaction, reported as follows: (1) "E. asked for Miss J., but was told that she had left the store to be married." (2) "E. looked disgusted, but told the clerk what kind of coat she wanted to buy." (3) "The clerk brought one that answered the description and two others." (4) "E. remarked that the collar was too large." (5) "The clerk said that collars were larger this year." (6) "Without saying anything, E. tossed her head, pursed her lips, and walked out." This second report is entirely one of description and throws into relief the inferences of the first report. For example, the second statement in the first report is not an observation, but an inference. The third and fourth statements do not agree with the second report.

After examining these two reports, we may say that: E. was disappointed or confused in this situation, possibly because her first approach had been blocked (1). Her observations were colored by her own attitude, as is indi-

cated by the more precise observations in the second report (3 and 5). E. evidently failed to distinguish between the observable facts and what she wished to infer.

**Quantitative measurements.** In the above illustration, units of measurement were not involved. In some investigations, time is an important variable that we wish to measure. A stop watch recording in fifths of a second and operated by one of the judges may be adequate for timing a 440-yard race, but it is open to criticism for the 100-yard dash both because the unit of measurement (the fifth of a second) is too large and because the reactions of the timer may vitiate the record. For still shorter periods, smaller units are necessary and the timing mechanism must be independent of the observer's prejudices. Under special laboratory conditions, if the subject is instructed to press a key as quickly as possible when he sees a light flash, his reaction time will be approximately .190 of a second. For a sound, the reaction time will be .145 of a second. In such cases a unit of .001 second is valuable (see page 35).

**Hypothesis and theory.** In popular parlance we distinguish sharply between fact and theory. We want facts and we are inclined to scoff at theories. This is partly because popular theories often distort or neglect some of the facts, and partly because we fail to recognize that what we call "facts" are frequently factual interpretations. Interpretation and theory are important in science, but both must follow rather than precede the data or facts collected.

In any investigation, we must first form from the facts at hand a hypothesis which explains them without distortion. This interpretation or understanding of the related facts is all that is meant by "hypothesis." A hypothesis is not a final but a tentative interpretation,

and is constantly being modified, supported, or rejected on the basis of the evidence of new data, or on that of a better analysis of the old data.

After it has been subjected to thorough investigation and examined in the light of all the available data, the hypothesis is considered verified if these data fit it. This hypothesis then becomes a theory. Thus, we have the theory of color vision, the theory of emotion, the theory of nerve conduction, and so forth. These are not mere verbalizations of the armchair variety, but statements of fact as the facts are now known, though further investigation may make modification or rejection necessary.

**Scientific proof.** After the hypothesis has been verified, it must be proved. Scientific proof is a definite method sharply distinguished from historical proof or proof in the popular sense. The scientific experimenter must formulate experimental conditions under which the phenomena may be observed by anyone who has adequate scientific training.

Scientific proof is important in psychology. Adherence to it excludes the armchair method, animal stories, casual observations, and reference to one's own experience which cannot be duplicated by another. The mere statement that a certain thing happened in a particular case under certain circumstances is inconclusive because no one can ever be certain that the description of the circumstance is sufficiently comprehensive, that is, that certain details are not omitted from the account or that certain details specified are not erroneous.

Lloyd Morgan relates that on one occasion he threw his stick over the fence, whereupon his dog, who had learned to retrieve the stick, slipped through a hole in the hedge, picked up the stick, and started to return with it. As he had seized it by the middle, it would not go

through the hole. Time after time he dropped it, only to seize it again and make for the hole. Finally he seized it nearer one end than he had on any previous occasion and was able to drag it through. A passer-by who witnessed only the last performance remarked on the wisdom of a dog that was able to judge the best way of getting a long stick through a small hole. This man lacked the information regarding the previous history of this dog, as well as complete data regarding the present circumstance, and he was also burdened with preconceived notions which would make accurate interpretation of the facts difficult.

Fond mothers read into the behavior of their children motives and interpretations which they cannot isolate from the specific observation. Their reports are thus valueless to science.

**The objective methods of psychology.** To the extent that psychology adheres to the principles outlined in the foregoing paragraphs, it may be considered a branch of science, for its methods and material do not differ radically from those of any other branch of science. For convenience, we will speak of the investigator as the experimenter (*E*), and the person being investigated as the subject (*S*). The data secured may be in any one of three types of response:

1. The explicit bodily responses, such as the movement of the hand, the winking of the eye, or frowning, which can be directly observed by *E*.

2. The implicit bodily responses, such as changes in circulation, the secretion of certain glands, or the metabolic rate, which can be observed only indirectly by the use of certain instruments or chemical analysis.

3. The verbal reports of *S*, such as his statement, "I was afraid," upon being presented some fearful stimulus; "I see red"; "I hear a tone"; or the like.

These are generally considered the objective data of psychology. That is, any of such data that are observed by one investigator may be observed by another and the two sets of data may be compared, providing the conditions for the two observations are properly controlled. This is particularly true in experimental situations. The investigator must arrange the conditions of the experiment in such a manner that he has as nearly ideal control as possible, and must record the data by one, or all, of the three methods mentioned above. These data, in other words, may be in the form of:

1. Descriptions and measures of the overt behavior.
2. Quantitative measurements of implicit reactions.
3. Verbal reports of *S*, as, "Object *A* is farther away than object *B*."

**Direct observation.** To these methods may be added a fourth, that of direct observation of experience. In this case the psychologist would observe his own behavior. Many psychologists object to this "subjective" method as being inaccurate and incapable of verification. Regardless of our interpretation of "conscious activity," this method is fruitful in supplying information which may lead to the formulation of definite problems that may be investigated later by more objective methods. Thus, in one situation I am thrown into a rage, and in one of impending danger I experience fear. What is the difference between these two experiences? I can, perhaps, distinguish certain characteristics of the one experience which are not discoverable in the other. I can also observe that, as I write this sentence, I am engrossed in a certain activity, and that the playing of the piano downstairs causes certain interruptions in my train of thought.

All these observations are extremely inaccurate when

judged by scientific standards, yet they are important as the first steps in the formulating of problems for more accurate investigation. I may then set up an experiment providing different emotional situations:

1. I may observe the behavior of *S*, such as: his facial expressions, whether his face is flushed or blanched, whether he smiles or frowns, and whether he slumps in his seat or sits erect.

2. I may use special techniques for determining changes in circulation, respiration, metabolism, and so forth.

3. I may even secure and analyze his verbal responses, either by the general statements he makes in answer to questions, or by some form of the "association test."

4. Finally, I may ask him to report on his own direct observation of his experiences in the different situations as a starting point for the further development of my technique.

The fact that one observes directly that he is distracted by certain noises and other stimuli not connected with his task may lead to specific objective tests of the effects of distraction upon mental work. The investigator's results may or may not agree with his direct observations. In the latter event, he should continue his objective investigations to determine the cause of this discrepancy. In work and fatigue studies it is frequently found that the subject does better in the test after a certain amount of fatiguing work. Further studies indicate that this is due to the fact that the sensations representing fatigue act as stimuli or incentives to work harder under test conditions, in spite of the fact that *S*'s direct observations are that he is hindered by fatigue or distraction.

**Objections to direct observation.** The great difficulty with the method of direct observation arises when it is made use of as a final method. It serves very well as a starting point, but should be limited to that purpose, first, because the results cannot be verified by another investigator; and second, because it yields too easily to suggestion and distorted observations when an attempt is made to apply it to subjects other than the investigator himself. The procedure usually requires special training of the subjects, and this training is, of course, a suggestion of what the experimenter hopes to find. The avoidance of suggestion is sufficiently difficult under the best objective experimental situations.

## Questions for Review

1. Why is psychology no longer defined as the study of the soul or mind?

2. In what ways might geology and psychology be related?

3. Which of the following are statements of observation and which are statements of inference?

   (*a*) This morning I saw a man standing on the street corner.
   (*b*) He was cold and hungry.
   (*c*) His coat was tattered.
   (*d*) The expression of his eyes made me sad.
   (*e*) I could see that he had been a man of wealth.
   (*f*) He was disgusted with the world.
   (*g*) He asked for a dime with which to buy something to eat.
   (*h*) He took my refusal as an insult.
   (*i*) The last I saw of him, he was lighting a cigarette.

4. How would you go about a scientific investigation of whether red-haired people are more easily angered than others? What would constitute a hypothesis and what the proof in this problem?

5. Distinguish between hypothesis and theory on the basis of the discussion on pages 25 and 26. Give some examples of hypotheses and theories in the other branches of science.

6. What are the three types of data which are collected in a psychological experiment?

7. What is the objective method in psychology? What are the advantages of this method over the subjective method? What is the chief disadvantage of the subjective method? To what use may the subjective method be put in a psychological experiment?

## CHAPTER III

# The Experiment

In the first chapter we pointed out that mere naming is not explaining behavior. We must analyze by some systematic procedure the events that contribute to the total picture of the situation. In the second chapter we emphasized that the investigator must be unprejudiced: though he makes use of hypotheses, these are simply the formulation of conclusions on the basis of the facts already known. How may he proceed from this point in order to be assured that his observations are as little affected by his preconceived notions as possible? The following suggestions will be helpful:

1. He should have an objective; that is, it should be clear to him just what he is investigating. Here is where his hypothesis helps.

2. He should keep as constant as possible all factors except the one he wishes to investigate.

3. Whenever possible, in the administration of stimuli and the recording of reactions, mechanical apparatus should be used in order to eliminate the human factor.

4. When he has secured his data, he must analyze and classify ~~them~~.

5. His interpretations should be limited to the data, except as logical deductions based upon the data may extend the interpretations.

The experimental method is useful because it provides

a means of adhering to the rules of scientific investigation. It permits the isolation of a single event or variable while the other variables are held constant or eliminated; also, the observation may be repeated. A few examples of the experimental method will illustrate these contentions.[1]

## Reaction Time

(1) *Objective.* We wish to determine the time required to make a simple response, such as pressing a key, when a stimulus—sound or light—is given. We know that a human subject (*S*) can press a key, that he can discriminate a sound or light, and we already know from previous observations that his reaction is not instantaneous: it takes some short interval of time before he can react. We also know that *S* can understand simple, verbal instructions.

(2) *Controls.* *S* should be placed in a quiet room free from distractions, with as little opportunity or reason for moving about as possible. His finger should rest upon the reaction key and *only this finger* should be used throughout the experiment. The same time of day, the same diet, and the same routine of activities should be carefully controlled if the experiment is to be extended over more than one day. We have thus controlled most of the important variables. We cannot be sure that his interest or attitude will remain constant: the weather may change; he may be fatigued or hungry; he may catch cold. We must keep a record of such variables as we cannot control.

[1] Numerous examples of faulty description due to lack of the experimental attitude may be found in Joseph Jastrow's *Wish and Wisdom*, New York, D. Appleton-Century Company, 1935, especially pp. 94–108.

*S* is instructed, therefore, that during this period he is to keep his finger on the key and be ready to react as quickly as possible when he hears the sound. To further ensure a high degree of attention, the moment a stimulus is presented, a "ready" signal will precede the sound stimulus by about one second. After ten trials, *S* should be given a brief period in which to relax and rest. Then the experiment will be repeated. This procedure should be continued until the desired number of reaction times has been secured.

(3) *Apparatus*. A sound hammer, similar to a telegraph sounder, is placed near *S* but out of sight. In another room is provided the timing device or chronoscope. The chronoscope must be tested to ensure accuracy of recording. The chronoscope shown in Figure 2 consists of a constant-speed motor, which is started before the experiment begins. When the experimenter (*E*) closes a switch, the sounder in *S*'s room and a clutch in the chronoscope are simultaneously activated. The clutch starts the hands on the dial moving at the same instant that the sound occurs. When *S* presses his key, the clutch is released, and the reaction time will be registered in units of thousandths of a second.

(4) *Data*. Table I gives the results of an experiment with one subject in which the reaction was to an auditory stimulus. These data may be treated in several different ways. In the first place, we generally want to know what measure most nearly typifies the measures—reaction times, in this case—as a whole. The *mean* is one such measure, and is expressed by the formula

$$M = \frac{\Sigma X}{N},$$

where $\Sigma$ represents the sum, X the individual measures, and N the total number of cases. Thus, in the table

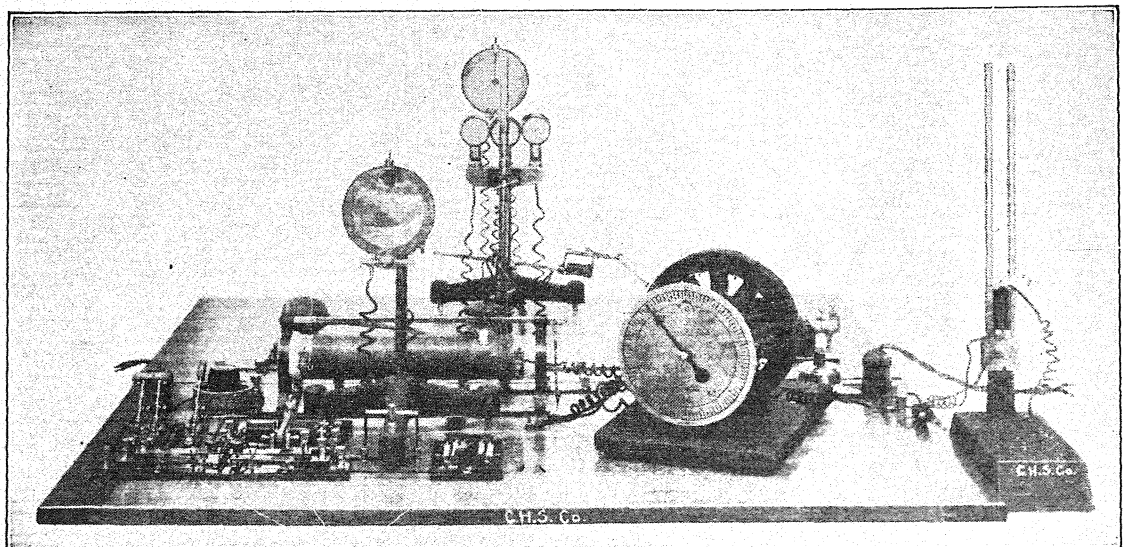


**Figure 2.—The Dunlap chronoscope and accessories for determining reaction times.** *A*, voice keys; *B*, chronoscope; *C*, electric tuning fork for control of the chronoscope; *D*, three-lamp visual stimulus; *E*, pneumatic reaction key; *F*, tactual stimulus key; *G*, telegraph sounder for auditory stimulus; *H*, control switches. (*C. H. Stoelting Co.*)

given, the sum of the measures, or reaction times, equals 15,003. This divided by 100, the number of cases, equals 150 milliseconds.[2]

This mean, however, does not tell us how nearly it represents all the data. As we run through the table, we find that the reaction times varied from 120 to 176. It is customary to use some measure of this variability. In simple cases where no further statistical computations are necessary, the *mean deviation* is quite satisfactory. This is expressed by the formula

$$\text{M.D.} = \frac{\Sigma\, d}{N},$$

in which d represents the deviation of each measure from the mean without regard for signs. Thus, in the table, the first reaction time is 17 greater than the mean, the second is 9 greater, but the third is 6 less. The sum of these deviations (d) divided by the total number of cases gives the mean deviation. In this particular set of data, the mean is approximately that most frequently found with most subjects under the same conditions of experimentation, but the mean deviation is small, only 9 milliseconds. "On the average" this subject did not deviate greatly from the central tendency, or mean. For another subject the mean was 147 and the mean deviation 21, showing that while he makes a better mean score, his results are not so consistent.

Graphic representation. We might also treat the data graphically. In Figure 3, reaction time is represented in units of five on the horizontal, or $x$, axis. The number of cases is represented on the vertical, or $y$, axis. Thus, three reactions ranged from 120 to 124, one from 125 to 129, and so on. It will be observed that reaction times

[2] A thousandth of a second is one millisecond.

TABLE I

REACTION TIMES OF ONE SUBJECT IN MILLISECONDS

| *No.* | *React. Time* | *d* | *No.* | *React. Time* | *d* | *No.* | *React. Time* | *d* | *No.* | *React. Time* | *d* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 168 | 18 | 26 | 158 | 8 | 51 | 163 | 13 | 76 | 158 | 8 |
| 2 | 160 | 10 | 27 | 124 | 26 | 52 | 125 | 25 | 77 | 140 | 10 |
| 3 | 145 | 5 | 28 | 140 | 10 | 53 | 158 | 8 | 78 | 172 | 22 |
| 4 | 176 | 26 | 29 | 164 | 14 | 54 | 153 | 3 | 79 | 132 | 18 |
| 5 | 163 | 13 | 30 | 172 | 22 | 55 | 146 | 4 | 80 | 147 | 3 |
| 6 | 158 | 8 | 31 | 150 | 0 | 56 | 120 | 30 | 81 | 149 | 1 |
| 7 | 150 | 0 | 32 | 145 | 5 | 57 | 136 | 14 | 82 | 144 | 6 |
| 8 | 147 | 3 | 33 | 147 | 3 | 58 | 146 | 4 | 83 | 156 | 4 |
| 9 | 152 | 2 | 34 | 150 | 0 | 59 | 140 | 10 | 84 | 148 | 2 |
| 10 | 174 | 24 | 35 | 138 | 12 | 60 | 148 | 2 | 85 | 159 | 9 |
| 11 | 159 | 9 | 36 | 165 | 15 | 61 | 170 | 20 | 86 | 162 | 12 |
| 12 | 161 | 11 | 37 | 136 | 14 | 62 | 138 | 12 | 87 | 143 | 7 |
| 13 | 154 | 4 | 38 | 152 | 2 | 63 | 168 | 18 | 88 | 130 | 20 |
| 14 | 157 | 7 | 39 | 156 | 6 | 64 | 145 | 5 | 89 | 138 | 12 |
| 15 | 150 | 0 | 40 | 150 | 0 | 65 | 163 | 13 | 90 | 149 | 1 |
| 16 | 140 | 10 | 41 | 157 | 7 | 66 | 150 | 0 | 91 | 140 | 10 |
| 17 | 152 | 2 | 42 | 153 | 3 | 67 | 152 | 2 | 92 | 147 | 3 |
| 18 | 155 | 5 | 43 | 161 | 11 | 68 | 159 | 9 | 93 | 164 | 14 |
| 19 | 148 | 2 | 44 | 159 | 9 | 69 | 155 | 5 | 94 | 138 | 12 |
| 20 | 140 | 10 | 45 | 140 | 10 | 70 | 157 | 7 | 95 | 145 | 5 |
| 21 | 150 | 0 | 46 | 176 | 26 | 71 | 140 | 10 | 96 | 138 | 12 |
| 22 | 136 | 14 | 47 | 152 | 2 | 72 | 155 | 5 | 97 | 147 | 3 |
| 23 | 120 | 30 | 48 | 151 | 1 | 73 | 140 | 10 | 98 | 150 | 0 |
| 24 | 146 | 4 | 49 | 150 | 0 | 74 | 136 | 14 | 99 | 141 | 9 |
| 25 | 153 | 3 | 50 | 158 | 8 | 75 | 146 | 4 | 100 | 139 | 11 |

within the limits 150–154 were the most frequent, though the wider range of 145 to 159 would probably be most representative. Extremely long or extremely short reaction times occur relatively infrequently. Possibly, verbal reports of the subject would have indicated that he was not ready in the case of the longer times and that he "beat the gun" in the shorter times, though this is not always evident from such reports. The exceptions are simply evidence of variable conditions which are measured by the reaction times.

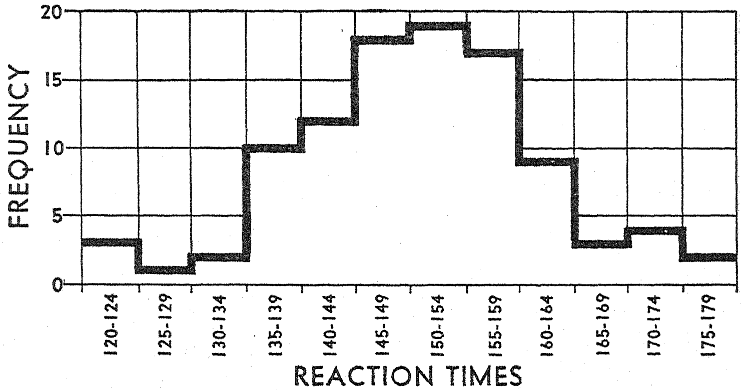


Figure 3.—The Distribution of Reaction Times of One Subject.

(5) *Conclusions.* The interpretations must be limited to the data in hand. If the same experiment should be performed with several *S*'s, we could state how much quicker one *S* is than another *in this test.* We could not say simply on the basis of reaction time measurement that one would be a better automobile driver than the other. Many occupations involve quick movements, but they also call for many other forms of behavior. These other abilities that are required may be more important or may at least compensate partially for slowness in the strict sense in which the term "reaction time" is here used. Readiness to respond, or alertness at all times, resistance to fatigue and monotony, freedom from emotional disturbances, steadiness, and skill are all factors.

## Selection of Personnel

The discussion of reaction time and industrial operations raises the important question of how one might apply psychological techniques to the selection of employees. We have indicated that it would be unscientific to con-

clude that because individuals differ in reaction times those with the shortest reaction time would make the best workers where speed counts. Space will not permit us to go into detail upon this point. It must suffice merely to state that each situation must be investigated in much the same manner that we described the investigation of reaction time.

Four important steps must be stressed:

1. The operations required of the worker must be carefully analyzed.

2. It is necessary to select tests which it is believed will measure these traits in the individuals.

3. These tests must be given to a group of workers whose ability is already known by the foreman or superintendent or can be ascertained from production records.

4. Those tests which prove satisfactory may then be given for the selection of new employees.

The investigation of the job might indicate that speed is an important factor. In this case the reaction time experiment, or some modification of it, might be used. But motor coördination, emotional stability, and several other traits might also be considered important, and tests for these too would then be necessary.

**The criterion.** The results of the tests are next compared with the known efficiency of the operators. This comparison involves the use of a formula which states the degree of agreement, or correlation, between the test and the *criterion*, or known efficiency. It will generally be found that some of the tests give a very low correlation. These should be discarded and, if necessary, new tests devised. When a battery of tests which give a high correlation have been collected, these may be given to new

applicants, and the applicants making the best scores selected.

**Fits and misfits.** Another use of such devices is the proper placement of workers already employed. The following example illustrates this procedure. A girl employed in a large factory was found incompetent in several departments where she had been tried. Before the end of her probation period, a laboratory had been set up in connection with the employment office, and she was sent back for examination. Under such circumstances a large variety of tests may be used to discover special abilities or special training, and a number of such tests were being given in this instance. This girl stood very low in all tests except those requiring manual dexterity in keeping up with a high speed set by certain tests. She was put to work at a machine which delivered the finished article in cartons at a high rate of speed. Her job consisted merely in placing these in boxes and keeping the table clear. At the end of two weeks she was receiving a bonus for high-grade work.[3]

## Experiments in Learning

In a similar manner, the problem of learning may be investigated. First, the material to be learned must be of uniform difficulty, in order that each series learned may be comparable with every other series throughout the experiment. Second, the data obtained must be measurable in quantitative terms, such as the number of repetitions or the time required for complete learning, or the amount learned in a given time.

[3] For a more extended discussion of the problems of vocational guidance and personnel selection, see Griffith, C. R., *An Introduction to Applied Psychology,* New York, the Macmillan Company, 1934, pp. 73–86 and 515–528.

For verbal learning, "nonsense" syllables (*moc, juf, tid,* and so forth) are frequently used. These must be carefully selected and tried out in preliminary tests with several subjects in order that those syllables which will give the most uniform results may be selected. The material is usually presented by an automatic exposure apparatus which exposes the syllables at a uniform rate.

If a series is thus learned in 17 repetitions and a week later 6 repetitions are required for its relearning, the saving of 11 repetitions is considered the measure of the subject's retention. If several subjects learn the same series under similar conditions, their learning ability for this type of material may be compared.

### The Method of Just Noticeable Difference

It is frequently necessary to determine within what limits the individual will respond to various stimuli and the nature of the response within these limits. Let us suppose that it is desirable to know how much difference in pitch must exist between two tones before a given *S* will respond to this difference.

We may start with two tones produced by two tuning forks, *A* and *B*, of the same frequency. If *A* alone is sounded and a moment later *B* alone is sounded, obviously *S* will distinguish, or discriminate, no difference in pitch. Now if *A* remains constant but the frequency of *B* is increased by very small increments, *S* will at first judge the two tones equal; but when the frequency difference is finally made sufficiently great by these small increments, he will report that *B* is now higher, or that there is a difference. *E* is able to determine by various methods how great a difference in frequency actually exists at this point.

However, this is not the end of the experiment. *S* knew that the two tones were equal at the start and that one would be gradually increased. He might, therefore, anticipate the shift, or, if he is inclined to be cautious, he might not be willing to say that he heard a difference, and would allow *E* to make the frequency difference still greater before he reported it. Thus, we should start again with a frequency difference great enough to be easily distinguished as two tones of unequal pitch, and by small steps reduce the difference until *S* reports the tones equal.

Theoretically, *S*'s last "unequal" report in this series should agree with his first "unequal" report in the preceding series. For reasons already stated, this will not necessarily be true. The point midway between the two readings would be more nearly correct.

We must further consider that an individual is a constantly changing organism. Hence, his discrimination in a case like this may not be representative. We must therefore repeat these two series in alternate order until we have secured several pairs of such judgments. The mean of these will be more nearly representative of *S*'s *differential threshold*, or his limit of discrimination of difference in pitch of two tones. There are several other methods which may be substituted, but each possesses the common objective, an accurate measurement.

### Observation without Experiment

It is not always possible to make observations in the laboratory and under experimental conditions. If the physicist wishes to study the law of falling bodies, he may place them one by one in a vacuum. The astronomer cannot so isolate a star or an element of a planet.

Gases surrounding the earth and the body to be studied, temperature, light, and motion are beyond his control. What he does is to devise instruments and methods which take these variables into account or render their effect negligible in the observations he wishes to make.

In the shopping "experiment" (page 24), which is really not an experiment at all, it is impossible to isolate and repeat at will one variable, that is, the behavior of the clerk. We take the situation as it is, but we try to control our observations. Though the laboratory experiment is the safest method, we must not neglect other methods of investigation or we shall overlook a large body of facts that are important for a complete understanding of human behavior.

## Questions for Review

1. Outline the steps in a typical scientific experiment. Are the steps in your outline adaptable for experiments in other branches of science as well as psychology? Does your outline agree with the one on page 33?

2. Why is it necessary that some measure of variability be used with every measure of central tendency?

3. The means of two sets of reaction times are 163 and 146 milliseconds, respectively. The mean deviations are 25 and 32. What do these results indicate?

4. What other unit could be used on the $y$-axis of Figure 3 without a change in the figures on the $x$-axis or the shape of the distribution? Draw a line on the distribution which will represent the mean reaction time. Should this line divide the area under the heavy line into two equal parts?

5. Of what use are the verbal reports of a subject in an experiment in which simple reaction times are being measured?

6. Apply the discussion on pages 39 and 40 to some other vocational problem, such as the selection of automobile drivers.

7. If experiment, as described in the preceding pages, were the essence of science, what fields of study now labeled as branches of science could not be included in such a classification?

8. If a task in a factory required high-speed operation all day, would the reaction time test be a good measure of ability in this task?

9. If you were asked to set up a psychological method for selecting assembly workers in a certain factory, what would be your procedure?

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## SECTION II—THE EVOLUTIONARY POINT OF VIEW

# CHAPTER IV

# The Organism

The following brief description of the nature of the living organism is not intended to be complete in any sense, but only to give the beginning student in psychology enough of the biological point of view to enable him to understand the principles of human behavior as they are discussed in the following chapters. Those students who have already devoted at least a year to the study of biology will have a better concept of living organisms than can be given here in a single chapter.

It is our purpose at this point to sketch the evolutionary development of the animal series from the lowest types of animal life to man. Naturally there will be wide gaps in the series as we pass from the simplest forms of matter, as it is at present understood by the physicist, up the scale to the first evidences of what we may call living protoplasm and from thence on to such complex forms as the higher vertebrates and man. The diagrams shown in Figures 4 and 5 give a rough notion of this ascending series from the simplest known elements of matter, the electrons and protons, to their most complex organization, man.

## The Physical Elements of Organisms

In order, therefore, to derive the full benefit from the study of the organism, it is important to know something

of the nature of the elements of matter as they are at present understood by the physicist and chemist. The living organism, and especially the human organism, is extremely complex, which fact has led in the past to the general inference that it is in some way set apart from the other forms of matter.

As science progresses, we become more clearly faced with the fact that even human behavior is best explained by reference to the laws that govern other forms of matter.

The higher types of living organisms are composed of cells—bone cells, muscle cells, nerve cells, and many other types of cell—which do not differ greatly from the lower single-cell organisms. Each cell in turn is composed of simpler elements, the molecules and atoms, and these have been split into still smaller elements and their properties carefully studied. We usually do not realize that the human being is really a synthesis of these fundamental elements.

It must be remembered, however, that though considerable progress has been made in recent years in the investigation of these "ultimates" of matter, as the physicist is inclined to think of them, the riddle of life is not solved. The results are only tentative, but we believe that they form a basis for a clearer understanding of the problems of human behavior than can be obtained by mere speculation. We therefore will present a brief description of the properties of these elements and their organization into living cells which move, take in food, and avoid harmful stimuli.

**Electrons and protons.** The physicist tells us that the ultimates of matter are tiny charges of electricity which exist in two unlike states. One has arbitrarily been called positive and the other negative. The specific name

for the smallest known amount of positive electricity that can exist as a unit is the "proton." A like amount of negative charge is called an "electron."

It can be shown that these elementary charges, when existing in certain relationships, compose the ninety-odd chemical elements. The simplest form is that of the hydrogen atom, which is composed of one unit positive charge with a unit negative charge rotating about it in much the same manner as the earth is believed to revolve about the sun. The helium atom has 2 electrons revolving about its nucleus, lithium 3, and so on up to uranium, the most complex of all, which has 92.

At the beginning of this century, atoms were supposed to be just tiny spheres having the properties of the material which the aggregate possessed. No one knew that lead, gold, hydrogen, and helium, differing widely in physical and chemical properties, were composed of the selfsame two materials. The neophyte is in the position of the Irish janitor in the chemistry laboratory, who, when the composition of water was explained to him, exclaimed, "Faith, and ain't there a bit o' water in it?"

**Organic and inorganic compounds.** Before the beginning of the nineteenth century, chemists described substances produced by animals and plants (sugars, fats, and so forth) as *organic* compounds; while all others were designated as *inorganic*, or mineral. It was believed that to form organic compounds from inorganic required the action of a vital force which was present only in living organisms. The production of organic compounds in the test tube was therefore deemed impossible.

In about 1828, however, the German chemist, Woehler, succeeded in synthesizing urea (an animal product) from potassium cyanate (a mineral). This discovery paved the way to future developments which wiped out the

original hard and fast line between organic and inorganic, until today, although the terms are still used as a matter of convenience, they have been redefined to mean those compounds which contain carbon and those which do not. (The compounds $CO_1$ and $CO_2$ are considered exceptions.) Other criteria, such as differences in reaction to heat, solubility, and velocity of reaction, are merely broad generalizations and do not hold in all cases.

**Organization.** It is a well-known fact that hydrogen and oxygen may combine to make water ($H_2O$). Yet water does not resemble either of these atoms. It has properties of its own which are not possessed by either hydrogen or oxygen. The existence of water is dependent upon the combination of two atoms of hydrogen and one of oxygen. We also know that water may exist in three different ways, as a solid, a liquid, and a gas. Chemical analysis would show that exactly the same constituents and exactly the same proportions exist in each; but through differences in temperature, the three forms of organization are possible.

To recapitulate, electrons and protons in combination form structures known as atoms; atoms combine to form molecules; and the molecules themselves may exist as gases, liquids, and solids. It should be further emphasized that the organization determines the form, and that this form is something more in appearance than the sum of the constituent elements.

**Protoplasm.** It is only a step from the organic compounds to protoplasm, which is a living substance and may exist as an independent living organism. Though it cannot be made by chemical synthesis, there is no reason to believe that it is not entirely explainable in terms of the organization of chemical elements. The difference,

therefore, between the living and non-living is one of organization, not substance.

**Why be scientific?** We may digress at this point to make clear that there are several points of view from

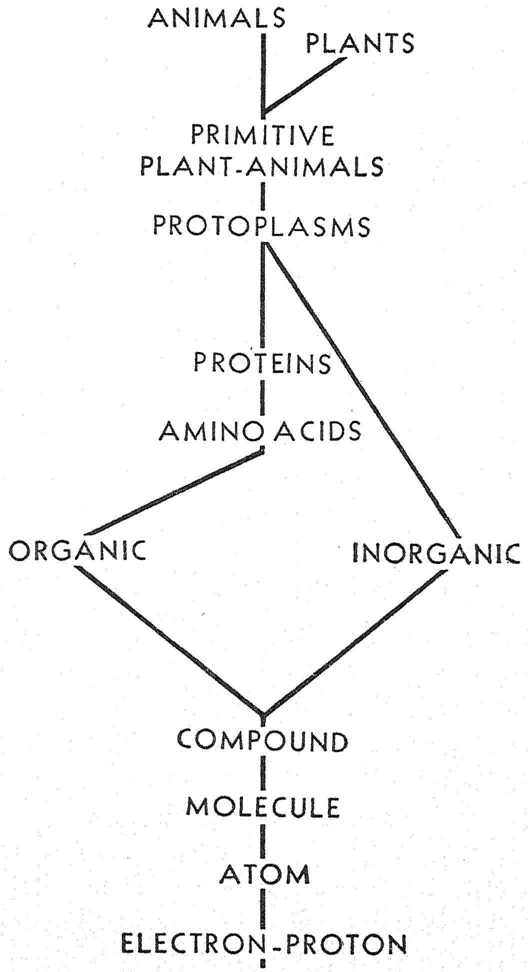


Figure 4.—A Family Tree of Physicochemical Organizations, Greatly Simplified.

which we may interpret our world and the nature of life. The poet may describe a sunset or a storm, the humble workman, or some great ideal in entirely different terms from those the scientist would use to describe them. Religion and philosophy, again, present different aspects of the same problems. It is the business of the scientist to set aside preconceived notions and investigate. He must follow the course which the results of his investigation lay out for him regardless of the consequences to the beliefs he may have held previously.

The results of science spell progress. What was deemed true yesterday may tomorrow be discovered to be only partly true or entirely false, but the scientist inevitably makes an advance in our knowledge. Instead of holding to the old views of nature and defending them by persuasive arguments, or refusing to acknowledge their inadequacy as satisfactory explanations, the scientist is willing to investigate. This is a tedious task, but it has resulted in the ability to forecast the weather, the development of modern transportation and television, the substitution of preventive medicine for incantations and charms, and more intelligent methods of dealing with such social problems as poverty, crime, and insanity.

As science pushes back the veil of ignorance, it does not make less important the function of art, poetry, religion, and philosophy. Rather, it makes possible in these fields a greater advancement to higher planes. On the other hand, art, poetry, religion, and philosophy may serve as motives for more intensive scientific investigation.

**Hesitancy in accepting a scientific interpretation.** While man first thought of all natural phenomena as being controlled by resident spirits, it was only natural that the first of these spirits to be denied should be those concerned with more remote happenings. Just as one is not

so concerned with what he says about a formidable enemy when he is at a safe distance, but is more careful when the enemy is close at hand, so man has always been hesitant to deny some non-physical power as the director of his personal relations.

Thus, astronomy, which deals with objects most remote from our intimate personal experience, was the first science to develop. Even powerful spirits at the tremendous distances of the stars could be more easily ignored than the nearer, and consequently more dangerous, devils responsible for disease and famine. Following hard on a scientific astronomy, we have the development of the other physical sciences, but it was not until the middle of the last century that biology attained the status of a science. The social studies, the most personal of all, only recently have accepted the scientific viewpoint to any appreciable extent.

**Living organisms.** On the basis of the arguments presented, we are led to believe that there is no distinct line of cleavage between the non-living and the living structures. The latter are less stable organizations, and hence more variable in their structure and resulting behavior. There is no definition of "life," therefore, but things are said to possess it when they perform the functions of (1) assimilation, (2) growth, (3) reproduction, and (4) irritability.

Figure 5 shows an abbreviated chart of living organisms, beginning with the primitive plant-animals, which comprise a poorly defined group. The *protozoa* comprise the simplest animals. There are some 8500 species of these. Some of them are known to cause malaria, syphilis, African sleeping sickness, and many other diseases.[1]

[1] Allee, W. C., in *The Nature of the World and of Man,* edited by H. H. Newman, University of Chicago Press, 1926, pp. 264 ff.

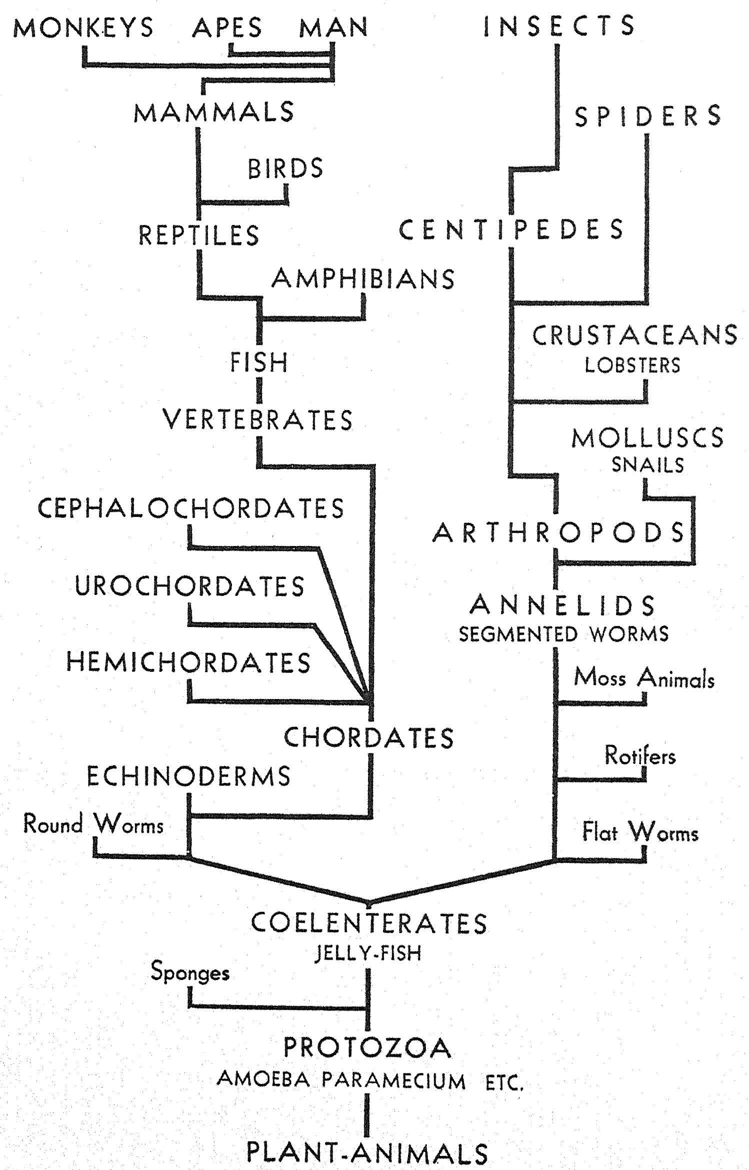


**Figure 5.—A family tree of the animal kingdom, greatly simplified.** For the origin of this series, see Figure 4.

This chart will be misleading if it is taken too literally. It is not intended to imply that man is a direct descendant of the fish or reptile. Nor is it proposed that man is on a level with the apes and monkeys. The chart merely shows the relative position in the scale according to structural similarities and differences. It is indicated, not that man is a descendant of the monkey, but that man, like the other forms of life, has had a long past. What this past has been will be briefly reviewed in the next chapter.

## Questions for Review

1. Why is the psychologist interested in the "ultimates" of matter as described by the physicist and the chemist?

°2. What is meant by the statement that the whole is more than the sum of its parts?

3. How is progress defined in the statement, "The results of science spell progress"? How may art, poetry, religion, and philosophy function in such a concept of progress?

°4. What is the distinction between living and non-living material?

°5. Explain why psychology was slower than physics in adopting a scientific point of view.

°6. What are considered facts of science today may be considered false tomorrow. Is this to be regretted or is it an advantage? Why?

7. Extend the chart in Figure 4 so that it includes the fields of study of the geologist, the astronomer, and the physiologist.

8. Extend the chart in Figure 5 so that it includes the fields of study of the sociologist, the political scientist, and the anthropologist.

CHAPTER V

# Man

**Origin of man.** It is the task of the anthropologist to investigate man's origin. What was the birthplace of the first human beings; what were they like; and how did they get along with other animals in those early days? The evidence has been collected slowly by persistent, painstaking effort. While a great deal of data have been collected, there is still more to be discovered. On the basis of the data concerning the first men and the present knowledge concerning the history of the other animals, there is no doubt that man evolved from some lower species.

Specimens of skulls, jaws, teeth, and other bones of the body reveal man, as we go back century by century into the distant past, more ape-like in structure. This does not signify that man is a descendant of the ape or monkey. Man and the ape may have been closely related at one time, but the monkeys and apes were only poor relatives at best. The progenitors of man must have possessed biological characteristics which determined that man should develop into the intelligent, inventive, culture-forming animal so superior to all his early near relatives.

## Apes and Men

Though recorded history covers a span of only a little over 4,000 years, it is known that man existed at least

500,000 years ago. A skull, part of the jaw, and a few teeth indicate that he was ape-like in appearance, with large jaw and teeth, receding forehead, and thick ridges over the eyes. He probably walked in a semi-upright posture and with a shambling gait. As the centuries passed, changes were taking place. Some of these changes would have spelled ruin in the struggle with other animals had it not been for the fact that other changes more than compensated for the weaknesses.

Thus, the teeth, generation after generation, were smaller and the jaw ceased to be effective as a weapon. But other variations, or mutations, were taking place. The brain was growing larger, and the hands were becoming more effective for manipulation. Though man was becoming a weakling, compared with the apes, he could stand upright. His eyes and hands could be used in coöperation with his brain for examining objects which the ape could not manipulate so delicately, see so clearly close at hand, or understand so fully with his more meager brain. Let us look at some of these structural differences as we find them in modern man and the ape.

**Upright posture.** In Figure 6 a chimpanzee, one of the apes, is shown standing as nearly upright as it is normally possible for it to do. More frequently, he will stand or walk with the knuckles of his hands upon the ground. In man the shape of the pelvis facilitates the more upright position. The attachment of the head and the neck muscles in man also makes this upright position more convenient than the semi-squatting posture of the chimpanzee. Doubtless these structural differences were an advantage to primitive man. He could be on the lookout for enemies or food, and at the same time his arms and hands would be free for purposes other than locomotion.

Figure 6.—The Female Chimpanzee of the Anatomy Department of the Johns Hopkins University.[1]

[1] Schultze, Adolph H., "Man as a Primate," *Sc. Mo.*, November, 1931, p. 389.

**Hands.** We have stated that the evolution of the human hand was one of the outstanding characteristics of the evolution of man which contributed to his great superiority over the other animals. Monkeys and apes possess hands with fingers and a thumb which resemble those of man, but the movements of these members are greatly restricted. If you will examine your own hand and observe the great variety of movements you can make, and then observe a monkey in the zoo, you will be struck with the difference.

For example, as you pick up a pencil and write, you make many delicate movements of the fingers, the whole hand, and the arm. You pick up the pencil with an easy movement of the thumb and first finger, switch it into place with the third finger, and then, if you have been properly taught, you rest lightly upon the paper the nails of the fourth and fifth fingers, and with an easy swing of the whole arm, you write in smooth curves. If you have not learned this easy method of writing, you may perform the still more remarkable feat of a set of complicated finger movements that accomplish the same end.

One outstanding characteristic of the human hand is that the thumb is opposable to the rest of the hand. The ape's thumb is small and rather useless for manipulative behavior. (See Figure 7.) The manipulation of tools is greatly augmented by the fact that the thumb may be opposed to the other fingers. The shape of the bones and the joints and the delicate arrangement of muscles make the human hand, in conjunction with the brain, an excellent instrument in the great variety of human behavior. Primitive man could fabricate tools, clothes, pottery, and so forth.

Much of what we call *thinking* may be classified as manipulation. We almost invariably pick up, or feel of,

A B C

**Figure 7.—Hands of two chimpanzees and an adult human being.** *A,* juvenile male chimpanzee; *B,* adult female chimpanzee; *C,* adult male. (*A. H. Schultze.*)

the small objects in which we are interested; we solve a problem with the aid of writing, by drawing diagrams, or by putting objects together.

Experiments indicate that apes and even monkeys can solve problems that involve the use of simple tools, but a study of their performance reveals that not only are they limited in the problems they can solve, but their solutions are generally crude whenever manipulation is involved.[2]

**Speech mechanisms.** Just as the more facile hand augments the variability of behavior, so does the differentiation of more highly developed mechanisms for vocal response increase this possibility. The development of language is one of the great accomplishments of man, and

[2] Valentine, W. L., "A Genetic Study of Manipulation," a movie film prepared at Ohio State University. Heinrich Klüver has made a motion picture film of a cebus monkey getting food that is out of reach. Though he is able to rake in the food, his movements are poorly coördinated.

this development is dependent not only upon his superior brain development, but also upon his vocal mechanisms.

We usually think of speech as resulting from the vibration of the vocal cords, more accurately described as two lips or folds in the throat or larynx. If these were all, we should be little better off than the other animals. The mouth and nose supply cavities for the resonance of the sounds produced in the throat. You know that if you remove the mouthpiece from a horn or clarinet, it will produce only a squawking noise. The rest of the instrument is necessary because it picks out and reinforces the proper tones produced by the vibrating reed on the lips. The mouth and nose assume these functions in the human voice, and the variations are produced by movements of the tongue, cheeks, and lips. Try to pronounce the vowels *o* and *a*, or try to say "Chimpanzee," without changing the position of the lips or tongue.

**Eyes.** The human eye has reached such a high degree of efficiency that in consideration of it, man is inclined to neglect the importance of his other sense organs. Many animals have to depend largely upon smell when they examine an object or follow a trail, while man uses his eyes. This is due not so much to the fact that man is defective in smell as to the fact that the human eye has become so much more important.

In the first place, man's eyes are placed in the front of his head; they rotate in their sockets and both see the same object. Furthermore, the human eye has acquired a small area of distinct vision, the fovea (Figure 18, p. 92). The lens in the front of the eye is capable of modification to permit distinct vision whether the object is at some distance or quite close. Thus, man can handle objects, turn them about, and at the same time

see them clearly; he can see objects at the side without turning his head; and because both eyes function together, he can learn to judge distances more accurately.

Brains. If we examine the two heads in Figure 6, we are struck by the difference in size of the foreheads. We have said that the brain of man has become much larger than that of the near relatives of the first man. This enlargement has taken place mainly in one part of the brain, the cerebrum. An examination of Figure 12 will show that this is the largest portion of the human brain. The remaining portion, lying below the cerebrum, is about as large in the ape, but the ape's cerebrum is greatly reduced. Man really possesses a great deal more cerebrum than he needs for a mere daily existence; but if it were not for this great overgrowth, he would not be able to make use of his superior hands and eyes to such advantage.

Summary. The superiority of man may therefore be briefly summarized as follows:

1. The upright posture, the freedom of the legs and their general musculature, provide more varied locomotor response and at the same time free the arms and hands for other activity.

2. The more delicate arrangement of muscles and bones of the arm and hand results in such complicated behavior as the construction and use of tools, invention, art, and so forth.

3. The high development of the speech mechanisms has provided man with a means of varied response which has resulted in the development of language. Through the language responses, man has been able to effect his present stage of social organization.

4. Coördinated eye movement and distinct vision of near objects make it possible for the hands and eyes

of man to coöperate more effectively in his learning of the details of the world about him.

5. The great overgrowth of the cerebrum beyond the needs for simple sensory-motor response makes it possible for man to utilize his other superior anatomical features for projecting his activity far beyond his immediate needs.

## Questions for Review

1. Enumerate some of the important structural differences between apes and men.

2. Point out some specific situations in everyday life in which the structure of man enables him to make a more adequate adjustment than could be made by the ape.

3. Give some instances in which man shows greater mastery of his environment than would be possible for the ape.

? 4. Why is it true that the difference between the ape and man at birth is more than simply a structural difference?

5. People born blind are not inferior intellectually to others, yet we have stated that the human eye is an important factor in the development of the race. How do you account for this apparent discrepancy?

6. Why should we adopt the evolutionary point of view in psychology?

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## CHAPTER VI

# The Nervous System

We have seen that the human brain has reached a stage of development which outranks that of the brain of any other animal. It will be to our advantage in the study of human behavior to know a little more of the detailed structure of this brain and the rest of the nervous system. It will also help us to understand these structures if we take a bird's-eye view of the evolution of the nervous system from the simple one-celled animals up to the higher vertebrates.

### Evolution of the Nervous System

**Amoeba.** The gross structure of the amoeba is very similar to the gross structure of the atom. The amoeba (Figure 8) consists of a differentiated center, or nucleus, surrounded by a mass of cytoplasm. The nucleus is separated from the cytoplasm by an exceedingly thin (1/40,000,000 cm.) membrane of low conductivity, and another membrane separates the cytoplasm from the environment. These membranes should not be conceived as insulating material on a conductor. They are composed of the selfsame material as the cell, and are constantly undergoing change, much as the surface film of water, oil, or mercury.

The amoeba, a mechanical structure, possesses an organization that we have chosen conveniently to call "life."

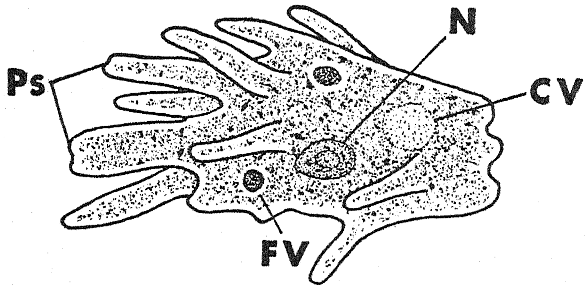



**Figure 8.—Amoeba proteus.** *CV*, contractile vacuole; *FV*, food vacuole; *N*, nucleus; *Ps*, pseudopodia.

There is no definition of "life," but, as we have previously stated, things are said to possess it when they perform the functions of (1) assimilation, (2) growth, (3) reproduction, and (4) irritability.

**Behavior of the amoeba.** Although the amoeba is a water-dwelling cell, it does not swim freely but rolls or flows along a solid surface by means of projections (pseudopodia) in the direction of locomotion. We conceive the locomotion of the amoeba to be due to stimulation, of course rather diffuse stimulation, in which the components can hardly be isolated. In addition, the amoeba responds to special stimulation, such as light, heat, electric currents, and chemical and mechanical stimuli. The reactions to the stimuli are few.

Thus, if we stimulate the amoeba with a strong light on one side, this side contracts and pseudopodia are put out in the opposite direction. If we place small, insoluble and inedible objects in the water surrounding the amoeba, the reaction is toward the particles (positive). If strongly stimulated, the animal moves away (negative). If we place food particles in the water, the reaction is positive and the particles are surrounded and taken into the cell.

There is no evidence of learning in the amoeba.? When insoluble carmine particles are ingested, they are quickly evacuated again, but no number of repetitions of this process produces a discrimination between an insoluble carmine particle and a soluble food particle to the extent that the food particle is ingested and the carmine particle ignored. If, however, two food particles are equally distant, it will "choose" one and neglect the other. The "choice," however, is an artifact. The animal "chooses" in the direction of the most sensitive side of the membrane. It will also continue to move in the same direction, once this is initiated, unless a counter stimulus, which sets up movement in another direction, is given.

**How can the behavior of the amoeba be explained?** The amoeba is a complex physicochemical system. Internal changes, which we call "metabolism," are constantly going on. There is also a constant interchange between the cell and its environment. If the environment is relatively constant, the organism reaches a state of relative equilibrium with reference to the environment. A stimulus (a change in the environment) results in a reduction of surface tension of the wall on one side and a consequent flow of the cytoplasm in that direction.

It is also to be understood that that part of the organism most recently stimulated is most active and hence most sensitive to later stimulation. This fact explains the continued movement in the same direction and the apparent "food seeking." It also explains why the amoeba goes to one food particle rather than to another. This side happens to be more sensitive at the moment.

The behavior of the amoeba has been thoroughly studied.[1] Without going further into the findings, suffice

[1] Mast, S. O., and Pusch, L. C., "Motivation of Response in Amoeba," *Biol. Bul.*, Vol. XLVI, p. 55, 1924.

it to say that there has been discovered no activity of the amoeba which cannot be explained in terms of physical chemistry or biophysics. The amoeba does not back away from a harmful stimulus because he is afraid of the consequences. Neither does he advance upon food material because he foresees that his "hunger" will be satisfied. He does what he does because of his structure and its dynamic relations with its environment.

**Development of differentiated structures.** As structure becomes more complex in the ascending series, so the function becomes intricate and more finely adjusted. The single cell of the amoeba performs all the functions we call "living," but the work may be much more efficiently accomplished and the chances of survival more extended through a multiplex aggregation of cells and a division of labor between them. The adjustment of the organism as a whole is much refined if one group of cells becomes specialized in the function of contraction, another in conduction, and a third in excitation.

For the psychologist, the most important specialized structures are those that are involved in excitation and in the conduction of this excitation to other structures. It should be remembered, however, that the total organism is composed of cells. Some parts, such as the bones and hair, are dead cells. Muscles are composed of cells which assimilate food that is specially prepared and conveyed to them. They may also be directly stimulated, but their chief function is contraction. The behavior of muscle cells is therefore more limited than that of most one-celled animals.

Other cells, the white blood corpuscles, differ very little from the amoeba in either structure or behavior. Still other cells constitute the glands and the other tissues of the body. Those that function especially in transmit-

ting impulses from one part of the body to another are known as *neurones*. They serve to integrate the organism; that is, they make possible a more adequate functioning of the organism as a single unit.

## The Human Nervous System

**Neurones.** The cells which compose the nervous system are of various shapes and usually possess numerous branches. Most other types of cells are regular in shape with few or no branches, but in the neurone the branches are often the major part. The cell body proper is a small fraction of a millimeter in diameter, while the longest branches may be a meter, or more, in length. The neurone is composed of protoplasm containing a nucleus, as are other cells. The branches are merely continuations of this protoplasm.

The typical neurone has many branches known as *dendrites*, so named because of their tree-like appearance. It also has a single branch, the *axone*, which is always slender and retains its original size throughout its length. The dendrite carries the nervous impulse toward the cell body and the axone carries it away from the cell.

The majority of the long axones and the long dendrites which resemble axones are covered with a sheath of whitish substance, the myelin sheath. It is believed that this sheath aids in the conduction of the nervous impulse within the neurone because there seems to be a relationship between its presence and the behavior of the animal.

**Types of neurones.** There is the widest possible variation in the size and shape of neurones. (See Figure 9.) Some are equipped with a long dendrite and a long axone (*A*). These carry impulses from the skin and muscles into the central nervous system. (See page 77.) Others

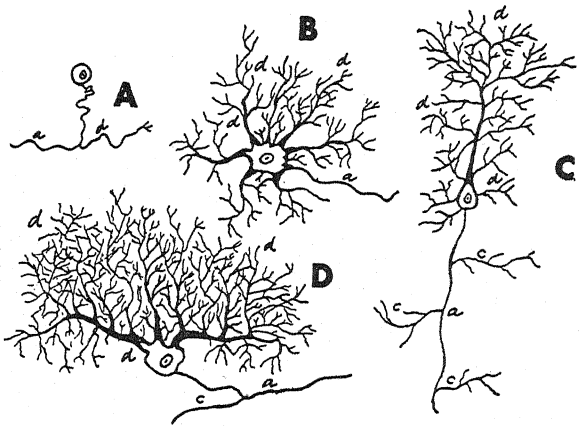



**Figure 9.—Several types of neurones showing different shapes of cells, and their branches.** *a*, axone; *c*, collateral; *d*, dendrite.

(*B* and *C*) possess profusely branching dendrites and a long axone. Some of these (*C*) carry impulses relatively long distances within the central system, while others (*B*) receive the impulse and convey it to the muscles. There are still some other types which by virtue of many short branches serve to link up the neurones into a more unified whole.

**The nature of the nervous impulse.** If a stimulus is applied to a nerve ending, such as one of the dendritic processes in the skin, the disturbance may be transmitted in some form through the neurone. In the preceding pages this has been referred to as a *nervous impulse.* Several investigators in this field have brought to light some interesting facts, though the problem of nerve conduction still remains baffling at many points.

On the basis of the data at hand, it seems clear that the nervous impulse is a physicochemical process presenting many of the features suggested in our explanation of

the behavior of the amoeba. It has been shown that when neurones are active, there are temperature changes and an increased consumption of oxygen and elimination of carbon dioxide, and that an electric potential is set up between the active and inactive regions.

These electric changes are the indication of the chemical changes or metabolic activity going on within the cell. We think of them as a series of discharges. First, the stimulus causes a chemical change in the region of its application; this change results in a similar change in the adjacent region while the first region is returning to its original condition; and so on through the length of the neurone.

**Peripheral and central nervous systems.** In the evolution of the nervous system in the lower animal forms, the cell bodies become more centralized and the branches connecting with the surface of the body become correspondingly elongated. This results in greater effectiveness in the connection of each neurone with every other neurone, which connection provides for the coöperation of every part of the organism in any response to a change in the environment.

This centralization may be likened to the system of communication in a highly organized army. General headquarters is in close touch with every unit, directly with the larger units and indirectly through subdivisions with the smaller units. If an advance is made in one sector of the front line, this sector is coördinated with other sectors, with the line of supply, and with reënforcements. Whether an attack is made will depend upon every other unit, and will in turn affect each of them. In the highly organized nervous system, similar coördination and reënforcement are brought about.

In the vertebrates, the nervous system becomes cen-

tralized in the spinal cord, which occupies the cavity within the spinal column, and the brain, which for convenience is designated as that portion of the central nervous system included within the skull. There is no essential difference between the brain and spinal cord, except that the brain is enormously more complex in interconnections of neurones.

The peripheral system, which includes all neurones and branches outside the brain and cord, is divided also for convenience of treatment into the skeletal system, which furnishes the nerve supply of the skeletal muscles and sense organs, and the autonomic system, which is connected principally with the internal organs, such as the heart, stomach, and intestines.

The cell bodies of the neurones that carry impulses to the spinal cord (afferent neurones) are grouped into ganglia, or bundles, along the cord. Their axones then enter the cord in bundles as the "posterior roots." These afferent neurones, it should be understood, carry impulses originating from stimulation on the surface of the body and from stimulation resulting from contraction of the muscles.

The motor neurones (efferent neurones) originate within the cord, and their axones leave the cord as the "anterior roots." The peripheral branches of both the afferent and the efferent neurones unite into bundles or "nerves," like the wires in a telephone cable. In the so-called "skeletal" system, all connections between neurones with a very few exceptions take place within the central nervous system—the spinal cord, in this case.

The autonomic system. There is a division of the peripheral nervous system that deserves special attention. This resembles the widely distributed nerve groups found in the lower animal forms before the nervous system

became centralized. Because it appears relatively independent of the central system, it is generally called the "autonomic" system. Though it is considerably decentralized, it does not possess complete autonomy.

The ganglia, or bundles of neurones, are distributed in various parts of the body, particularly in the body cavity. They regulate some of the internal functions, such as digestion, the secretion of certain glands, a special type of muscle which is found in the stomach walls and arteries, and the ciliary muscles of the eye. (See Figure 40.)

This autonomic system is connected with the central system through two rows of ganglia along the cord. Thus, the hierarchy is established. A pinch or prick of the skin results in a dilation of the pupils. An exciting story makes the heart beat faster. Worry, fright, or excessive physical exertion has its counterpart in internal reactions of the viscera.

Functionally, the autonomic system differs from the skeletal system in that here we do not recognize any direct control. We say we can move our arm or twitch a finger as we please, but we cannot increase our heart rate or stop digestive processes, except by indirect stimulation as illustrated above.

**The spinal cord.** We may think of the spinal cord as a coördinating center, though much less extensive in this respect than we shall find the brain. A prick of the finger may cause a quick withdrawal of the hand. A receptor, or sense organ, in the skin has been stimulated; this impulse has been conducted to the cord and thence, by a motor neurone, to the muscle.

The situation is not so simple as it sounds. In the cord, several neurones were affected. Some of them were motor neurones running to various muscles in the arm and fingers. Others connected with still other neurones

at higher and lower levels in the cord, so that we find that not only was the hand withdrawn but other muscles of the body contracted. The subject may have "caught his breath." Furthermore, if our subject had known what was to happen, he might not have withdrawn his hand. Neurones in the brain as well as neurones in the cord would have been involved.

In cross section, the cord displays an *H*- or butterfly-shaped mass of gray matter in the center surrounded by white matter. As already explained in the description of the neurone (page 71), this would indicate that the gray matter is composed principally of cell bodies, dendrites, and the endings of axones, while the white matter is composed of long axones in the white myelin sheaths. Hence, the gray matter is the center of interchange of impulses between neurones (synapses); and the white matter conveys the nervous impulses up or down the cord. A few of these connections and conduction paths are indicated in Figure 10.

**The brain.** The brain differs from the cord only in its size, shape, and enormously increased complexity. The brain, especially the cerebrum, is the most distinctive feature of man as compared with the lower vertebrates. Man's brain, together with his hands and vocal organs, is primarily responsible for his preëminence in the development of a social order, inventions, ideals, and culture.

The gray matter is no longer a continuous central mass in the brain, as we found was the case in the cord, but is distributed in various regions within the lower portions of the brain and the cerebrum, and also in the surface layer, or *cortex,* of the cerebrum and the cerebellum (Figures 11 and 12).

Time will not permit the tracing of these paths or the description of the major functions of the various cortical

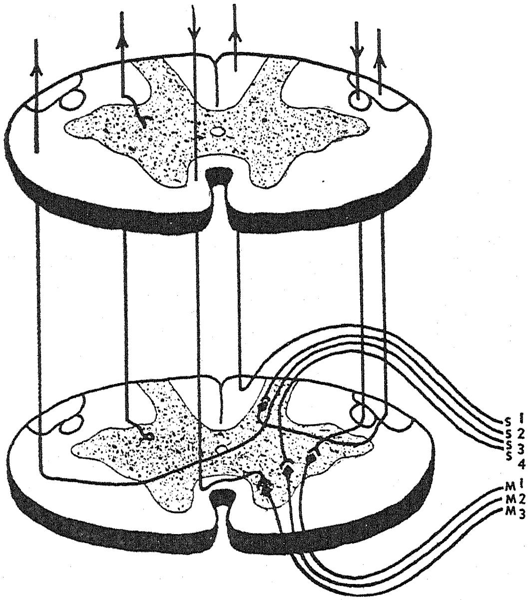



**Figure 10.—Diagram of various groups of neurones and their continuation in the spinal cord.** S1–S4, sensory or afferent neurones in the posterior root; M1–M3, motor or efferent neurones of the anterior root.

areas and subcortical ganglia. It is sufficient at present to recognize that the neural activity at this level is of the same order as that of the lower centers in the cord, except that it here becomes enormously complicated.

Some understanding of the complexity of the human brain may be gained from the following figures: Donaldson[2] estimates that there are about twelve thousand million ($12 \times 10^9$) cells in the human cortex alone. But this is only a part of the story. According to Herrick,[3]

[2] Taken from Herrick, C. J., *Brains of Rats and Men,* University of Chicago Press, 1926.
[3] *Ibid.*

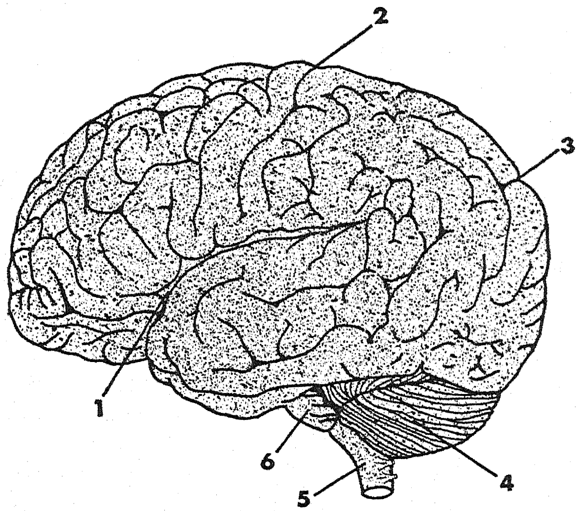



**Figure 11.—View of the left side of the adult human brain.** 1, fissure of Sylvius; 2, fissure of Rolando; 3, parieto-occipital fissure; 4, cerebellum; 5, spinal cord (medulla spinalis); 6, pons.

if a million cortical nerve cells were connected one with another in groups of only two neurones each in all possible combinations, the number of different patterns of interneuronic connections thus provided would be expressed by $10^{2,783,000}$. The number of actual connections probably exceeds this figure, but even this figure is greater than the number of atoms in the entire solar universe.

It should again be emphasized that we are never really dealing with isolated nerve patterns, but with the total neural pattern; not only with the total cortical activity, but with the activity of the subcortical and peripheral portions of the nervous system as well. Whether we have under consideration the simplest type of response or the more complex processes of thinking, the integration of the total neuromuscular system is involved.

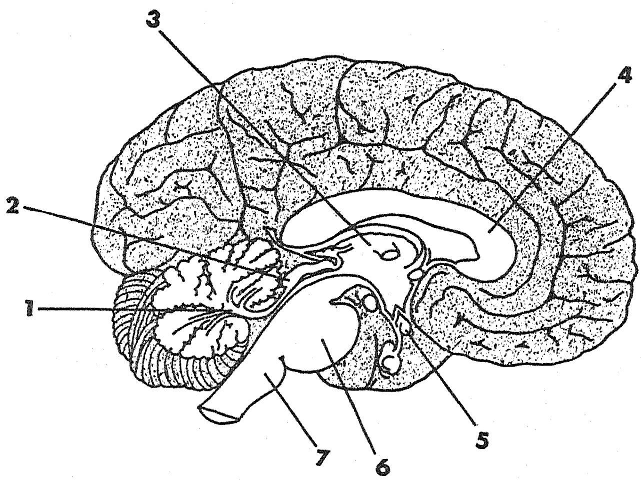



**Figure 12.—Vertical median section of the brain, showing the left half.** The cerebrum is the great convoluted mass filling more than half the picture. 1, cerebellum; 2, corpora quadrigemina; 3, thalamus; 4, corpus callosum; 5, optic chiasm; 6, pons; 7, medulla.

## Questions for Review

°1. How is the behavior of amoeba in situations involving "choice" or "preference" to be accounted for?

2. List the various types of cell differentiation in the human organism. Give the functions of each of these groups of cells.

3. The neurone is sometimes called "the element of the nervous system." Show in what sense this is true.

° 4. Which of the following physical analogies are most similar to the nervous impulse: water running through a pipe; a row of piles of gunpowder connected with fuses; electricity passing over a wire conductor?

5. The nervous system has been said to be analogous to an elaborate telephone system. Carry out this analogy as far as possible and show the function of each of the various divisions of the nervous system.

6. What is meant by the phrase "neural overgrowth"?

°7. In what way is the nervous system responsible for the greater variability of the behavior of man?

°8. In what way would you expect the behavior of an individual to be modified if he should lose part of the cerebral cortex through an accident or surgical operation?

### Reference

Herrick, C. J., *The Brains of Rats and Men,* University of Chicago Press, 1926.

## SECTION III—TYPES OF SIMPLE BEHAVIOR



References to Student's Guide:

# CHAPTER VII

## Stimulus and Response

**Sensory-motor response.** All behavior is dependent upon stimuli, and stimuli, in the case of such a highly complex organism as the human being, act upon sense organs, or specially developed receptors, which excite activity in neurones. These, in turn, transmit the activity to other neurones in the central nervous system. The activity is finally transmitted to muscles and glands. This process is known as a *sensory-motor response*. It exemplifies the unity of the individual and his environment.

We have already noted in the description of the spinal conduction pathways (pages 75–77) that a nervous impulse enters the cord over an *afferent* neurone. This may connect with an *efferent* neurone and be conducted out of the cord to a muscle. In Figure 13 we represent this possibility. If a stimulus is applied to the receptor,

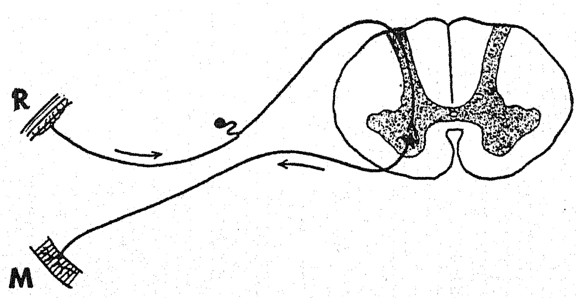



**Figure 13.—Diagram of a Simple Spinal Reflex Arc.**

*R,* it sets up a physicochemical activity which is transmitted along the afferent neurone to the gray matter of the cord. Here it is transferred to the efferent, or motor, neurone which conveys the impulse to the muscle, whereupon the muscle contracts.

This may be considered the simplest possible type of sensory-motor response, but it is really a mere abstraction so far as normal human behavior is concerned. Actually, the stimulation of one receptor is accompanied by the stimulation of many receptors. Furthermore, the numerous neurones thus affected connect with many other neurones.

The neurones also possess collaterals on their axones, some of which ascend the cord while others descend the cord. This is illustrated in Figure 14. Since many of these neurones have branches that extend to the brain as well as to different levels of the cord, there are involved an almost unlimited number of neurones that can influence the final efferent impulse and the muscles that contract. What we ordinarily consider a simple sensory-motor response is, therefore, actually quite complex.

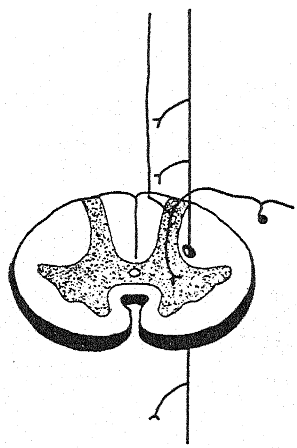


**Figure 14.—Diagram Illustrating Ascending and Descending Collaterals.**

**Organization.** It is not always possible to identify the stimuli that are affecting the organism, nor is it always possible to observe that a response has taken place when a stimulus has been applied. You may observe a friend who is sitting quietly in a chair with a book in his lap.

Is he thinking, or solving some problem, or dreaming? Could he even tell you what has been going on, if you should ask him? Again, what are the stimuli that are responsible for the present state of his activity? Sounds, light, temperature, and the changes in his own organism may be the stimuli. The clock stops, and he gets up to wind it, showing that he was being influenced at the time by its ticking or he would not have "heard" it stop. Or he may suddenly have remarked that he has decided to go on a fishing trip next summer. Something he had been reading shortly before—it may have been a single word—was a stimulus that started a series of responses that finally ended in the remark regarding the trip.

Thus it must be recognized that all behavior is the result of stimuli acting upon receptors. Neither these stimuli nor the action of receptors determines the character of the behavior. They merely initiate the activity. One does not always hear the clock stop, and he does not necessarily get up and start it again. On some occasions it is pleasant to hear the clock tick; on others it is annoying. The afferent impulses are distributed to numerous central neurones which finally determine the efferent neurones that will conduct the impulses to muscles. These central neurones furnish the *organizing* mechanism.

**The characteristics of stimuli.** There are a number of factors concerning the stimulus which we can only briefly describe at this point. To reiterate what has already been stated, we should point out that:

1. A stimulus is any physical change which acts upon a receptor. This change may be in the form of vibrations we call light rays, or vibrations which affect the auditory receptors to produce sound, pressure upon the skin, or chemical changes that give us our tastes and smells.

2. We more frequently react to stimulating situations than to a simple stimulus. This means that not only one stimulus and one receptor are involved, but that many stimuli and many receptors function simultaneously.

**The receptor.** The receptor, or sense organ, is a specialized structure with which the dendrites of the afferent neurone are connected. Its function is to increase the efficiency in setting up the nervous impulse for particular stimuli. Thus, the eye is the specialized receptor for light, and in the skin there are special receptors for pressure and temperature.

We may distinguish certain other characteristics which are directly due to the nature of the receptor and the neurones connected with the receptor:

1. Any stimulus must act for a certain minimal time before it can elicit a response. This time is known as the *initial lag,* or as the *latent period* between stimulus and response. (See Figure 15.) In this case the curve represents the number of impulses set up in a receptor and nerve by stimulation of the receptors in the muscle. It will be seen that the initial lag, from the time the stimulus is applied until the maximum reaction is attained, is about five seconds in this case. In other receptors it might be shorter or longer.

2. The stimulus must possess a certain minimal intensity. A pressure on the skin may be too light to be felt, or a vibration may be too weak to be heard as a sound. The point at which a stimulus is just intense enough to elicit a response is termed the *initial threshold* of sensitivity.

3. If a stimulus is continuous, the receptor mechanism becomes adapted or partially fatigued. This is illustrated in the second phase of the curve of Figure 15. Though this is true of all stimuli, it is particularly noticeable with weak stimuli. We notice

that the room is too warm when we enter, but we become used to it. The light of our lamp has a faint yellow cast, but we soon become "blind" to the color of it.

4. When the stimulus is withdrawn, the receptor continues active. This is the *terminal lag*, and is represented by the third phase of the curve in Figure 15.

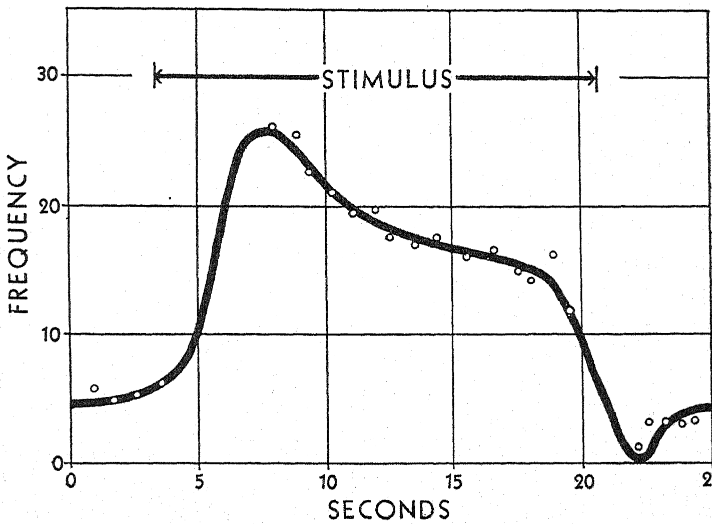



**Figure 15.—Curve showing the frequency of impulses produced by stretching the muscle.** *(Adrian, p. 65.)* Frequency may be interpreted in this case as intensity or vigor of response.

## Classification of Receptors

**Primitive receptors.** Perhaps the most primitive, and, at the same time, among the most important, receptors are those in the skin and muscles. (See Table II, page 94.) If a metal point heated to about 50°C. is passed over the skin, it is found that at certain spots a sensation of warmth is aroused. If the exploring point is cooled in

ice water, cold spots are found, and these do not correspond to the spots that are found to be sensitive to warmth. Spots sensitive to touch and others sensitive to pain may also be located. Evidently, four different types of receptors are located in the skin, though at present their structure is little understood.

These receptors, together with those of the muscles (giving kinesthetic sensation), are important in furnishing knowledge respecting contacts with the environment and the movements made but also play a very important part in the development of our knowledge of objects and our adjustments to these objects. Even the adult individual is inclined to handle the object he is examining. The "feel" of the object adds to the knowledge gained by the mere sight of it.

There are also specialized taste receptors in the tongue that react to solutions to produce salt, sweet, sour, and bitter. The other so-called tastes, or flavors, are due to the simultaneous stimulation of receptors in the membrane of the nose. Thus, most "tastes" are a combination of taste and smell.

Hunger, thirst, and other organic responses that are not so definitely analyzable must also be the result of the stimulation of receptors in the alimentary canal and other tissues. Perhaps their lack of definiteness is a result of the fact that they do not play so specific a rôle in the behavior of the individual. We are inclined to say, "I hear someone hammering next door," "I see a book," or "A bee stung me on the neck," but we say, "I feel hungry," "I am thirsty," "I feel tired."

**Equilibrium.** The "static sense" is often referred to the semicircular canals which are located near the receptors of auditory stimuli in the inner ear, though they have no function in common with these receptors. (See Fig-

ure 16.) These canals assumed an important rôle in the investigations of the qualifications of aviators, as it was supposed that when in the air, a flier would of necessity have to depend upon the stimulation of the hair cells of the semicircular canals to determine his position.

That these canals do function in the maintenance of equilibrium is illustrated in the behavior of pigeons when one or more of these canals have been destroyed. Certain phenomena observed in laboratory experiments on the rotation of subjects are also indicative of their function.

That the semicircular canals are not the only source of our cues regarding the position of the body or our ability to maintain balance is shown by the fact that pigeons in which the canals have been destroyed are able after a time to walk erect and to fly like normal pigeons, and that in

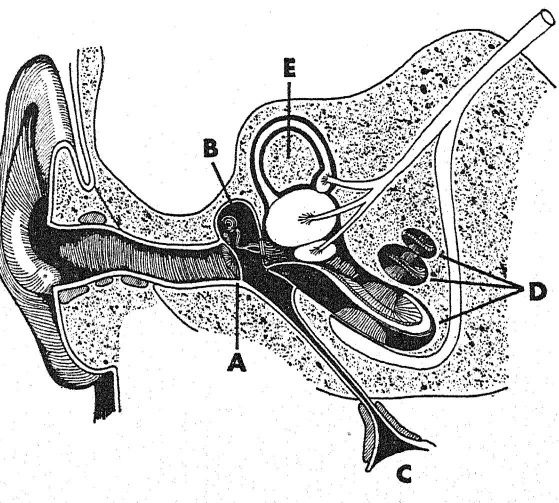



**Figure 16.—Cross section of the skull showing the relationship of the middle ear, cochlea, and semicircular canals.** *A,* tympanic membrane; *B,* middle ear; *C,* Eustachian tube connecting middle ear and pharynx; *D,* cochlea; *E,* semicircular canals. *(Hough and Sedgwick, "Human Mechanism," Ginn and Company.)*

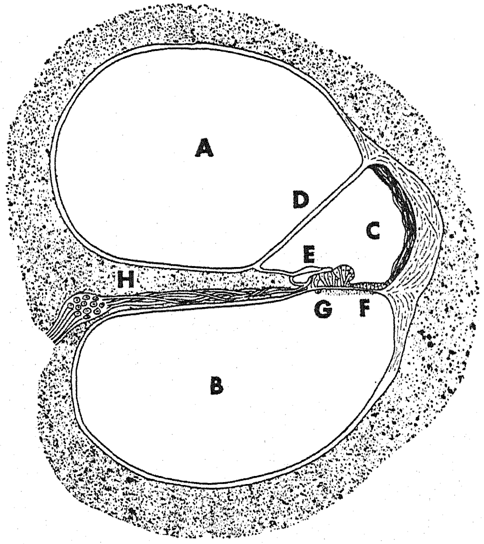



**Figure 17.—Transverse section of the cochlea showing the basilar membrane, the rods of Corti, and the sensitive hair cells.** *A,* scala vestibuli; *B,* scala tympani; *C,* cochlear canal; *G* and *F,* basilar membrane on which are the rods of Corti and hair cells; *E,* tectorial membrane; *H,* spiral ganglion containing the cell bodies of the neurones which make up the auditory nerve. *(Modified after Foster.)*

many human subjects these canals have been destroyed by disease or operation and yet these people display no ill effects. Stimulation of the skin and muscles, shifting of the visceral organs, and visual stimuli all have an important part in the maintaining of equilibrium.

The ear. One of the most highly specialized receptors in man is the mechanism in the ear (Figures 16 and 17). It is affected by vibrations ranging in frequency from 20 to 22,000 per second. Low frequencies are heard as low tones and higher frequencies as high tones. As these vibrations, as alternate condensations and rarefactions of the air, enter the ear, they impinge upon a membrane, the

drum or *tympanum*. The vibrations are thence conducted by three small bones to the inner ear, the *cochlea*. Here tiny brain cells, the true receptors, are stimulated. It is probable that some respond to one frequency and others to other frequencies.

We can distinguish in tones very slight differences corresponding to less than one vibration for the average person and one-fifth of a vibration for the trained musician. Vibrations are usually not simple, several of different frequencies occurring at the same time. These combinations are what distinguish a clarinet from a violin, or a good violin from a poor one, and the quality of one voice from another. Our ability to discriminate these slight differences and the combinations of tones makes possible the appreciation of music, the development of speech, and the everyday discriminations necessary in a world of sound.

The eye. We have previously spoken of the human eye as being one of the outstanding characteristics of man. The complication of its functioning is even more baffling than the intricacies of the auditory mechanism of the human ear. Light waves, commonly described as ether vibrations, enter through the pupil, pass through the lens, and are focused upon the retina (Figures 18 and 19). This retina is the sense organ or receptor of vision. Wave lengths from 760 mμ[1] to 640 mμ give us what we call "red." Shorter wave lengths give us orange, then yellow, and so on, until we reach the limit with violet at 390 mμ. Highly specialized neurones in the retina, known as *rods and cones,* receive the stimuli. We see grays and colors by means of the cones, but only grays by means of the rods. At a central point, the *fovea,* there are only cones, packed together closely. We have

[1] mμ = .000001 millimeter.

previously referred to this as the point of clearest vision. Toward the periphery of the retina, the cones diminish in number and the rods increase, until at the extreme periphery practically only rods are found.

There are a number of interesting characteristics of vision which can be described only briefly here:

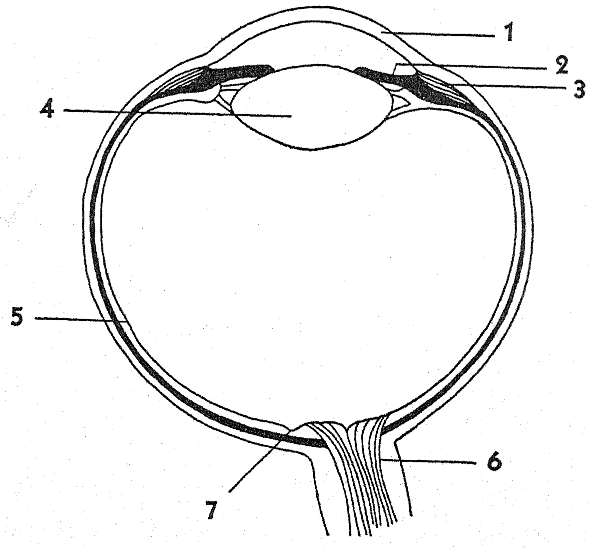



**Figure 18.—Diagram of cross section of the human eye.** 1, cornea; 2, iris; 3, ciliary body; 4, lens; 5, retina; 6, optic nerve; 7, fovea.

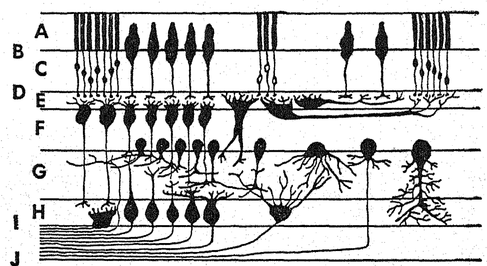



**Figure 19.—Diagram of the principal structures of the retina.** *A*, layer of rods and cones; *E*, outer synaptic layer; *G*, inner synaptic layer; *H*, ganglion cell layer; *I*, axone layer.

1. *Dark adaptation.* If we pass from a lighted room to a darkened room, at first the room seems absolutely dark, but in a few minutes we begin to see objects, particularly out of the corners of our eyes. The rods become more sensitive in the dark.

2. *Afterimages.* If we look at a small area of color for about thirty seconds and then look at a plain gray surface, we see another color which is the complementary of the original. Thus, if we look at yellow, we will see a blue afterimage.

3. *Color mixture.* If two wave lengths corresponding, say, to red and a bluish green enter the eye, we see gray. The two colors, being complementary, cancel each other.

4. *Color contrast.* If we look at a sheet of colored paper over which is placed a narrow strip of gray, we will observe that the narrow strip appears to be colored the complementary of the surrounding color.

5. *Color zones.* If a small area of color is seen by the extreme periphery of the retina, it appears gray. If it is yellow or blue, it will be seen in its true color when it is moved in slightly toward the center of the retina. If it is red or green, it will be necessary to move it in somewhat nearer the center. The normal eye is partially color-blind in the outer zones of the retina.

**Color blindness.** A few persons do not see red or green at all, or else they see them very poorly. A student was shown a card on which there was an arrangement of dots of various shades of red and green. Most persons see that the red dots form the figure "6," but this subject could distinguish the colors only as differences in brightness, or grays which formed the figure "5." He further stated that he could not see ripe cherries on a tree from a distance of a few yards, and that red apples looked like colorless balls.

TABLE II

TYPES OF RECEPTORS, THEIR SPECIFIC STIMULI, AND THE RESULTING REACTIONS

| *Sense Department* | *Receptors* | *Stimulus* | *Reactions* |
|---|---|---|---|
| Cutaneous....... | Skin<br>Corpuscles (?) | Temperature<br>Contact<br>Pressure | Cold, Warm<br>Touch, Pain |
| Gustatory....... | Mouth<br>Papillae | Solutions | Salt, Sweet<br>Sour, Bitter |
| Kinesthetic...... | Muscle, tendon<br>Muscle spindles, etc. | Pressure<br>Movement | Movement<br>Pressure |
| Olfactory........ | Nose<br>Epithelial hair cells | Vapors | Unclassified |
| Organic......... | Alimentary canal<br>Other tissues | Tissue conditions | Hunger<br>Thirst<br>Pain, etc. |
| Equilibrium..... | Semicircular canals<br>Muscles, muscle spindles, etc. | Movement<br>Muscle tension | Movement<br>Pressure |
| Auditory........ | Ear<br>Hair cells of cochlea | Vibrations 20-20,000 per second | Tones<br>Noises |
| Visual.......... | Eye<br>Retinal rods and cones | Light rays 760-390 $m\mu$ | Colors<br>Brightness |

**Limitations of environment.** We ordinarily think of the environment as all the forces that surround us. From the standpoint of behavior, some elements of the environment can have no effect because of the lack of proper receptors on the part of the organism. For example, the sounds we hear are the result of vibrations within a certain range of frequencies. If the frequency

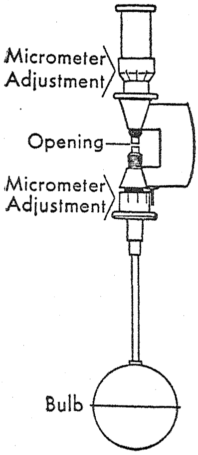



Figure 20.—Galton Whistle Used in Determining Upper Limit of Pitch.

exceeds these limits, the stimulus becomes ineffective, and we fail to hear a sound.

A simple demonstration of this fact for the upper limit may be made with the Galton whistle (Figure 20). Most young persons will hear a tone as high as 22,000 vibrations per second. On the other hand, with increasing age this limit becomes reduced, so that a middle-aged person may fail to hear a tone of 15,000 or 18,000 vibrations. The band of frequencies between 15,000 and 22,000 are effective stimuli for the younger persons but call forth no response in the middle-aged.

The limitation of our receptors is again illustrated by an inspection of Figure 21, which portrays the character of the electromagnetic spectrum or ether waves. It will be seen that the visible spectrum comprises only a relatively narrow band as compared with the total range of wave-lengths that are known. Within this narrow band are the effective stimuli for all the colors we see. These are the only waves to which the eye responds. Some of the sun's rays we do not *see* at all. A relatively wider band may stimulate heat receptors in the skin.

**Extending our environment.** One might ask, how do we know there are other waves if we do not have receptors which react to them? The answer is one of the significant features of human development. Man is able to extend his environment through the invention of instruments and the use of inference. The X-rays and the Hertzian waves, for example, cannot be known directly;

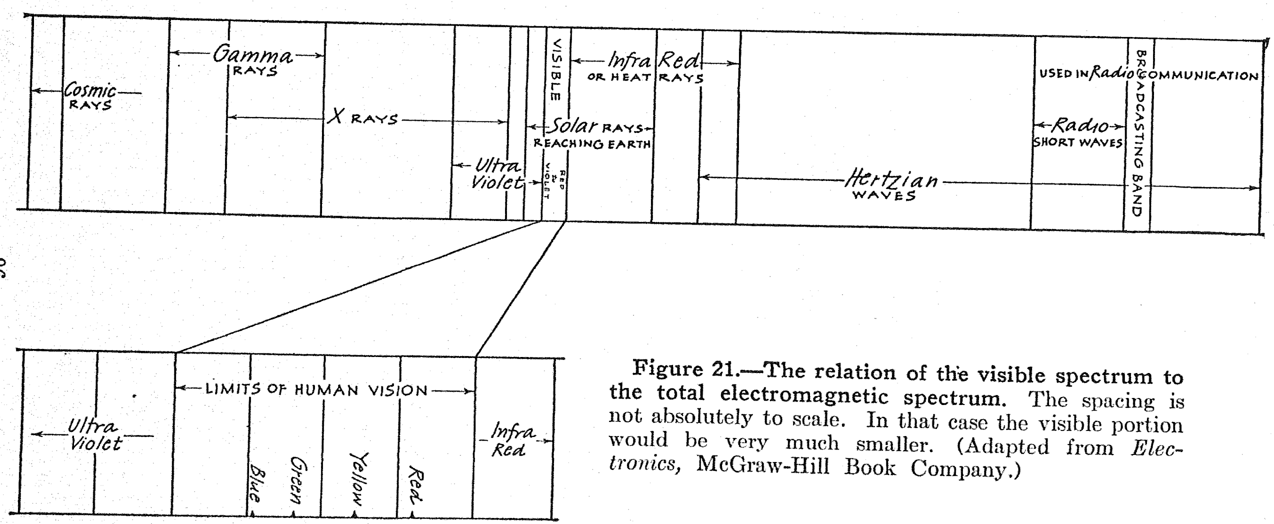



**Figure 21.—The relation of the visible spectrum to the total electromagnetic spectrum.** The spacing is not absolutely to scale. In that case the visible portion would be very much smaller. (Adapted from *Electronics,* McGraw-Hill Book Company.)

but by observing certain phenomena—the results of these rays—and by the use of instruments, man is able to infer or indirectly measure these rays. This is a concrete example of what we mean by human variability of response.

**The individual as environment.** We should also stress the importance of those stimuli which originate within the organism. Movements of all kinds stimulate receptors. Contractions of the stomach and the digestive tract, the circulation of the blood, metabolic changes, all furnish stimuli to activity. The contraction of the skeletal muscles also plays an important part. The child who is restless and fails to go to sleep though all external stimuli are favorable to sleep can often be put to sleep if its hands and legs are held so that it cannot struggle effectively. Thus, we must recognize that the environment with which we are concerned includes not only the immediate surroundings of the individual, but also the individual himself.

**Social stimuli.** Our behavior is affected not only by physical forces, as such, but also by the behavior of others. Social stimuli (for example, a word or a frown) are, of course, physical stimuli, in the last analysis; but they are sufficiently important to be classified separately. The sound of thunder is a physical stimulus to which we may react by hurrying to shelter before it rains. The sound of an auto horn is also a physical stimulus, but it may be social in the sense that we react to it as a warning from an approaching reckless driver or a friend who is calling. Physical stimuli are developed into social stimuli as they become associated with the behavior of other individuals. For this reason what is a social stimulus for one need not be a social stimulus for another. As most of our complex problems of behavior result from our relations within a group, we may expect that the

social stimuli are of very great importance in our lives.

The social environment extends far beyond the individual's immediate surroundings. Through modern means of transportation and communication we are influenced by the behavior of individuals far removed from our own community. We have recognized that the life in the city slums affects our own life. We have only recently begun to realize that the economic, political, and social life in distant foreign countries is also important to ourselves.

## Questions for Review

1. Trace the phenomena and structures involved in a simple sensory-motor response.

2. Make a list of the situations in which the behavior of a person occurs in the apparent absence of stimulation; then point out the possible, though obscure, sources of stimulation responsible for the observed activity.

3. Give a few examples of instances in which the responses to very obvious sources of stimulation are not readily observable. How would you go about determining whether or not there actually was a response under these conditions?

4. A well-known psychologist once said that he would allow anyone to inflict upon him the most painful stimulus imaginable provided he were allowed to postulate one condition. On the basis of the discussion on page 86, what condition do you think he postulated?

5. What part of the curve in Figure 15 represents the "initial lag"? How long was the stimulus applied? What part of the curve represents the "terminal lag"; the refractory phase?

6. Can you suggest another arrangement of the material in Table II which would result in more than eight sense departments? What does this table lead us to conclude regarding the notion that "man is endowed with five senses"?

7. When we eat ice cream too rapidly, we frequently complain of a "headache." Obviously, the intense cold is in the stomach, but is localized elsewhere. Can you suggest an explanation? What are some other instances of this phenomenon?

8. What are some situations in which color blindness would affect an individual's everyday behavior? Why is it that some people do not find out they are color-blind until they are 20 years old?

9. Color blindness refers to a deficiency in the visual sense department. Can you think of some examples of deficiencies in other sense departments? How would these deficiencies be manifested in the behavior of the individuals affected?

10. Coffee-tasters and winetasters are examples of individuals who are able to discriminate very small differences between stimuli. Can you give some other examples in other sense departments? Give an account of this ability.

CHAPTER VIII

# Types of Simple Sensory-Motor Response

The simplest type of behavior is generally described as a *reflex*. However, we have seen that no reaction of the human organism is particularly simple in the sense that it may be attributed to direct connection between receptor and effector.

Hypothetically, a reflex occurs when a stimulus, acting upon a receptor, initiates an impulse which spreads through the afferent neurone to the cord or brain where the impulse is transferred to the efferent neurone and thence to the muscle. Actually, however, a great many other connections would be involved. Or, to state the case in terms of behavior, the reflex depends not only upon the specific stimulation, but also upon the total stimulating situation and the total activity, or posture, of the individual. That is, it depends upon the stimulation of other receptors besides the one in which we are specifically interested, and also upon the total effect of the resulting neural processes within the total organism.

The patellar reflex. A common illustration of a reflex is the "knee jerk," or *patellar reflex*. If a person sits upon the table with his legs hanging freely and a light tap is given to the tendon just below the knee cap, there will be a sudden kick or extension of the leg. In this case receptors in the tendon have been stimulated by the blow on the tendon, and the impulse travels through the affer-

ent neurones to the spinal cord, where connections are made with the efferent neurones which run out to the extensor muscles of the leg.

If the subject experimented upon is required to clench his fists tightly at the moment the tendon is tapped, or to perform multiplications, the jerk or extension of the leg may be exaggerated. Or if he watches the experiment, the jerk may be reduced. Evidently other neural processes are also involved.

The exaggeration of the reflex by other activities is frequently explained as being due to *facilitation,* while the decrease in the reflex is referred to *inhibition.* In order to understand that the former is not so much a facilitation, or reënforcement, of the reflex as it is an inhibition of other impulses that were already interfering with the reflex, it is necessary to consider the mechanism that may be active under such conditions.

**Mechanism of inhibition.** When the tendon is struck, the nervous impulse is carried not only to the cord and thence out on an efferent neurone to the extensor muscle, but also along one branch of the afferent neurone which ascends in the cord to brain centers. Some of these brain centers, particularly in the cerebellum, control the strength and coördination of the motor impulses.

When a muscle contracts, it stimulates receptors within the muscle, and resulting nervous impulses travel into the cord and up to the brain. There are, then, two afferent impulses that may ascend to the brain, one resulting from a tap on the tendon and the other resulting from a contracting muscle. In the third place, the flexor muscle of the leg must relax as the extensor contracts. This can be accounted for by inhibition of efferent impulses to the flexor muscle taking place in the cord, though the inhibition may arise in the higher centers in

the brain. Other activity occurring at the moment the tendon is tapped acts as an inhibitor by blocking in the brain the impulses that would otherwise interfere with the reflex.

Evidence of the part played by the higher centers in the reflex is furnished by *tabes dorsalis,* a pathological condition in which the dorsal columns of the cord have been destroyed at some level. If the destruction occurs at the level at which the reflex connection is formed between the neurone from the tendon and the neurone to the muscle, the reflex will be diminished or absent. On the other hand, if the lesion occurs only above this level, the reflex will be exaggerated.

**Other tendon reflexes.** Characteristic reflexes may also be elicited from any other tendons that may be easily stimulated. A tap on the tendon at the elbow when the arm is loosely suspended will cause a jerk of the forearm. Tapping the tendon Achilles, the tendon that connects to the heel, will cause an extension of the foot. Similarly, skin reflexes may be elicited. If a smooth object is rubbed along the bottom of the foot toward the plantar of the great toe, the toes turn down. Stroking the skin of the abdominal area causes the contraction of the abdominal muscles.

**Function of tendon reflexes.** The significance of reflexes will be seen when the control of movements, such as walking, and the control of the use of the hands and arms, is considered. Not only are there conveyed to the muscles impulses which cause the muscles to contract, but the contraction of these muscles excites receptors in muscles and tendons which, in turn, modify the strength of such impulses. It is difficult to walk when the leg has "gone asleep." The tabetic walks awkwardly, if at all, because coördinations are interfered with by the

blocking off of afferent impulses originating in the moving members. Frequently, he substitutes visual cues (seeing the moving members) for the lost kinesthetic cues.

**Reflex behavior.** Many simple responses that resemble reflexes may be readily observed in our everyday behavior. If one steps on a sharp or slimy object or touches something hot, the foot or hand is withdrawn as quickly "involuntarily" as when a tendon is lightly tapped. Usually such responses occur when the stimulus is unexpected or intense. We say the response is involuntary because it seems to depend entirely upon the stimulus and because we seem to be unable to control it.

withdrawal

In many cases, with repeated trials or with knowledge that the stimulus is about to be applied, we are able to inhibit the response. Many times, if the stimulus evokes pain, we inhibit the withdrawal response by doing something else, such as clenching the fists and grinding the teeth, as well as contracting other muscles which more directly prevent the withdrawal.

It is quite probable that the great discomfort we suffer in the dentist's chair is due not so much to the dentist's operations as it is to the fact that we are not able to react as we would to other painful stimuli. We cannot while the dentist is working set our teeth together as we habitually do on other occasions when we are painfully stimulated.

**The ocular reflexes.** We can distinguish three types of reflexes of the eyes, one of which is not at any time within the immediate control of the individual while the other two are frequently controllable with difficulty. If the intensity of the light increases or decreases, the pupil becomes correspondingly smaller or larger. If the light

intensity is excessive, the pupil becomes a mere pinhole in the iris, and at the same time we say that the light hurts our eyes. This reaction is due to the greater strain of the contraction of the constrictor muscle. With the enlargement of the pupil in dim light, the constrictor muscle is relaxed and the opposed dilator muscle contracts. The dilator muscle, however, does not contract to the extent of causing pain.

Closely related to the reaction of the pupil to light is its reaction to near and distant objects. If one observes the eye of a subject as he looks at an object across the room and then at a point held within a foot of the eyes, he will observe that the pupil contracts as the subject fixates the near object.

The light reflex serves to control the amount of light that enters the eye, while the constriction during fixation of a near object serves to give us a more distinct image of the object, just as shutting down the diaphragm of a camera increases the sharpness of the picture. We say that these reflexes occur automatically because no other activity of the subject has any effect upon them.

**Wink reflex.** The second type of ocular reflex is not, strictly speaking, an eye reflex, but is directly related as a protection to the eye. This is the *wink reflex.* It is induced by an object approaching near the eye, by a bright flash of light, and by the drying of the eyeball. This, then, is a purely protective reaction. Careful observation shows that the wink is not merely a quick closing of the lid, but a movement downward and toward the nose. This sweeping movement thus carries dust particles toward the nasal corner of the eye where they may be washed out by the tear secretion.

It is interesting to note that the wink is not so easily

controlled as at first might be supposed. If one tries to keep his eyes open under conditions which ordinarily induce a wink, it will be only a few seconds until he experiences a severe burning of the eyes, and very soon the wink occurs in spite of all he can do to prevent it.

Several people were watching a cobra strike against the glass walls of its confinement. It was noticed that each time the cobra struck, all the observers winked. It was proposed that they try to inhibit the wink, but in spite of the fact that the cobra had repeatedly demonstrated that he could not break through the glass, no one of the observers was able to avoid winking. This led to an investigation of the problem in the laboratory.[1]

In the experimental situation, a framed plate glass was set up before the subject. A headrest was so adjusted that the subject's eyes were only a few inches from the glass. On the opposite side of the glass was a padded hammer with the handle so attached at the base of the frame that it could be pulled away and, when released, would be pulled, by a strong rubber band, against the glass with a definite thump on a level with the subject's eyes. Table III gives the results obtained with 1,141 children ranging in age from 5 to 15 years.

Only the median,[2] maximum, and minimum numbers of winks before the wink could be controlled are shown in this table. It will be seen that for the boys at 7 years there is a definite decrease of the median number of trials required before the wink can be inhibited. The girls do not do so well, but there is a definite drop at 8 years. Some children required a great many more trials than others. In some cases more than 300 trials were neces-

[1] Partridge, G. E., "Experiments upon the Control of the Reflex Wink," *Amer. Jour. Psych.*, 1899-1900, Vol. XI, pp. 244-250.

[2] The *median* is that measure lying midway between the two extremes when the measures are arranged from the smallest to the largest.

TABLE III

Showing the Number of Winks Necessary Before the Gaining of Control. (Partridge, p. 247.)

| | Boys | | | | Girls | | | |
|---|---|---|---|---|---|---|---|---|
| *Age* | *Tot. Cases* | *Least No.* | *Median* | *Greatest No.* | *Tot. Cases* | *Least No.* | *Median* | *Greatest No.* |
| 5 | 55 | 1 | 38 | 218 | 52 | 0 | 40.5 | 286 |
| 6 | 53 | 1 | 22 | 199 | 53 | 1 | 27 | 171 |
| 7 | 48 | 1 | 4 | 326 | 55 | 1 | 13 | 175 |
| 8 | 50 | 0 | 3.5 | 127 | 50 | 1 | 17.5 | 378 |
| 9 | 51 | 1 | 3 | 191 | 52 | 0 | 6 | 315 |
| 10 | 48 | 0 | 3 | 233 | 49 | 0 | 9 | 291 |
| 11 | 52 | 0 | 2 | 140 | 47 | 0 | 4 | 248 |
| 12 | 55 | 1 | 3 | 69 | 53 | 0 | 23 | 335 |
| 13 | 58 | 0 | 2 | 81 | 55 | 0 | 4 | 221 |
| 14 | 67 | 0 | 1 | 261 | 54 | 1 | 3 | 325 |
| 15 | 47 | 0 | 1 | 71 | 37 | 1 | 2 | 105 |

sary, and more girls than boys required the excessive number of trials. This explains the higher median for girls at the 12-year level.

An interesting test of inhibition of the wink can be demonstrated in the gymnasium with a volley ball net. Let the subject stand behind the net just so far that when the ball is thrown against the net, it will approach within 3 feet of the subject's face. With his hands at his sides, he is to stand perfectly still. Two observers stand on either side of the subject to check observations of the wink. It will be found that most subjects wink every time in spite of the fact that repeated trials demonstrate that the ball cannot reach their faces. If the subject is now allowed to put up his hands in a protective position each time the ball is thrown, he is generally able to avoid winking. This substitution of one protective response for another again indicates that the so-called reflexes are not so simple as we are wont to describe them.

**Eye movement.** The third type of ocular reflex has to do with eye movements. If a bright spot of light appears in the outer area of the field of vision, the eyes turn in that direction. This reflex, however, under most conditions can be more easily inhibited than the wink. That it is not so easily controlled as might be supposed is illustrated by the weariness or fatigue of the eyes which we experience when subjected to irregular illumination. When one looks from the window of a moving train or walks beside a tall picket fence through which the sun is shining, the passing objects or intermittent flashes of light set up eye movements. The tension of antagonistic muscles which is present in our effort to maintain steady fixation upon one object results in eyestrain or fatigue.

Similarly, fatigue in reading is reduced by uniform illumination, such as indirect or diffused lighting. If one reads under a single light source, such as a table or floor lamp, the eyes tend to react to the irregularly illuminated areas as the eye moves along the line. The antagonistic reactions necessary to maintain fixation result in the greater fatigue.

In the normal adult, both eyes move to fixate, or look directly at, the same object. If the object approaches the face, both eyes converge, or turn in toward the nose. If it moves across the field of vision, both eyes turn in a pursuit movement. This pursuit is not a uniform movement of the eyes, but is accomplished by a series of jerks, or reflexes. If one observes the eyes of another person while he is reading, he will note that the eyes make several of these little jerks for each line, with brief pauses between. In general, briefer pauses mean faster reading.[3]

[3] Huey, E. B., *The Psychology and Pedagogy of Reading*, New York, the Macmillan Company, 1908.

A motion picture, "Eye Movements in Reading," has been prepared by W. L. Valentine and Maurice Troyer, the Ohio State University.

Other responses that may be classified with reflexes are coughing, sneezing, the peristaltic movements in swallowing, and the rhythmic contractions of the stomach. In each case a stimulus acts upon a receptor. This receptor, in turn, sets up in the afferent neurone an excitation, which is transmitted to the efferent neurone and to the muscle.

**Unstriped muscle response.** The chief difference in the response of the smooth, or unstriped, muscle and the action of the striped muscle is that the former reacts more slowly. Both the latent period following the stimulus before the muscle begins to contract and the refractory period, or time before the muscle will again respond to a stimulus, are longer than in the case of striped muscle. To observe this difference, watch the pupil contract when stimulated by a bright light, and compare this contraction with the quick wink reflex. The muscle fibers that surround the pupil and control its size are of the smooth muscle type, while the muscles involved in the wink are striped muscles.

Smooth muscle responses play an important, though not so obvious, part in the behavior of the individual. The smooth muscles are supplied with afferent neurones which connect through the ganglia of the autonomic nervous system with the central nervous system. Hence, the contraction of these muscles may have a regulating influence on other responses.

**Glandular responses.** The sensory-motor response need not be limited to the response of muscles alone. A stimulus may result in the secretion of a gland. A piece of food in the mouth is a stimulus to the flow of saliva. Dust or other irritants stimulate the tear glands. These are representatives of the glands of external secretion, so named because they discharge their fluid to the

exterior through a duct. Another type that is attracting widespread interest is the ductless gland, or gland of internal secretion, whose secretions are taken up by the blood as it passes through the gland.

It is only recently that the importance of the ductless glands has been realized, and at present the evidence of their functions is rather conflicting. It is quite apparent, however, that they not only play an important part in metabolism, but, in some cases at least, directly exercise an important rôle in the behavior of the organism. They are supplied with neurones which regulate their secretion.

The result of the response of these glands is to release a substance which has an excitatory or depressive effect upon certain tissues of the organism very similar to the stimulation of the receptors in the contracting muscle. Because of the excitatory character of some of these secretions, the name *hormone,* which is a Greek derivative meaning "excite," has been applied to them. As these secretions may in some cases have an inhibiting effect, the term *autacoid* has been suggested as preferable.

## Questions for Review

1. Trace the simplest path of the nervous impulse involved in the stimulus-response mechanism of the patellar reflex.

2. What evidence can you cite to show that the reflex in human behavior is always dependent upon more than a simple stimulus?

3. What learned responses can you identify that are of the order of reflexes?

4. State two methods of inhibiting the wink reflex.

5. Why do your eyes become fatigued (*a*) when viewing a flickering movie, (*b*) when looking out of the car window in a moving train, and (*c*) when reading in a moving train?

6. What initiates the reflexes of eye movements in reading?

7. Name some unstriped muscle reflexes the results of which can be directly observed. How do these reflexes differ from striped muscle reflexes?

8. Name two glandular reflexes which may be directly observed in your own behavior. What other glandular reflexes can you observe by their effects upon your behavior?

# CHAPTER IX

## Maturation and Learning

All behavior is dependent upon structure. We could not make delicate, coördinated movements of the fingers if we did not possess delicately adjusted muscles, neurones, and sense organs; we could not observe a painting and appreciate its beauty if we lacked a material portion of the nervous matrix of the cerebral cortex; and we could not make plans for the future, invent machines, or create great ideals if we were structurally different from what we are. We behave, think, and feel as we do because of what we are.

We note this dependence upon structure not only when we compare the behavior of lower animals with man, but also when we observe the behavior of the human infant. He cannot understand what is perfectly simple for the adult. A part of his deficiency may be ascribed to lack of experience, but much of it must be attributed to lack of development. These two processes, maturation and learning, must always be considered in relation to each other. Maturation is the process of growth whereby the state of complete development is attained. When we say that a boy is growing, we mean that he is getting larger. When we say that he is maturing, we mean that he is attaining the size of the normal adult. Learning is the modification of response tendencies consequent upon experience. This modification is also related to some sort of change in structure.

## Maturation and Behavior

**The development of sensory-motor response.** An instructive study of the relation of behavior to the growth and development of the neuromuscular system has been made with the larval amblystoma, the salamander in the tadpole stage.[1] A tadpole represents the embryonic stage in the maturation of this organism. As the nervous system of the human infant at birth has passed the embryonic stage and is so nearly matured that it is difficult to correlate its further maturation with behavior development, the tadpole offers an excellent opportunity for the study of this development. Coghill has divided the development of its behavior into these five stages:

1. *The non-motile stage.* The muscles can be excited to contraction by direct stimulation—by the stab of a sharp needle, by mechanical impact, or by electricity—but cannot be stimulated by a light touch on the skin.

2. *The early flexure stage.* The animal first responds to a light touch on the skin. The movement is executed by a bending of the head to the side opposite the stimulus. The movement is slow, and is performed by the serial contraction of the muscle segments. As the embryo advances in age, the muscular contractions extend farther down until the entire trunk is involved (Figure 22*A*).

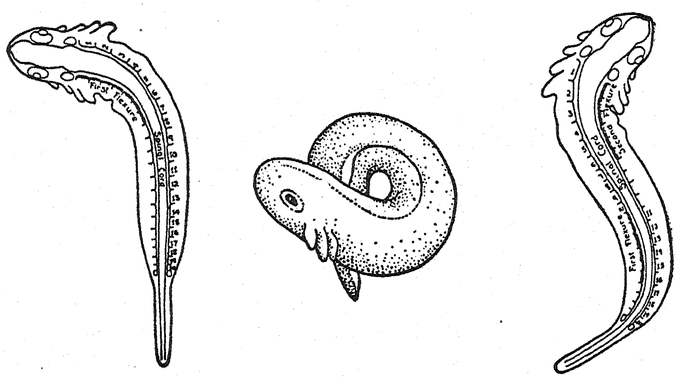
3. *The coil stage* follows closely the flexure stage and is marked by a bending into a tight coil. This coil may be reversed immediately into a coil in the opposite direction (Figure 22*B*).

4. *The "S" reaction.* This reaction is characterized by the reversal of a flexure before it is completely

[1] Coghill, G. E., *Anatomy and the Problem of Behavior,* New York, the Macmillan Company, 1929.

executed as a coil. As the wave of contraction passes down one side, a second wave of contraction starts on the other side at the head-end (Figure 22*C*).

5. *Locomotion.* Swimming is effected when the "S" reactions in series are sufficiently strong and rapid to propel the embryo.




A B C

**Figure 22.—Three stages in the behavior development of amblystoma.** *A*, diagram to illustrate the first flexure stage; *B*, tracing of a photograph taken while the coil reaction was being performed; *C*, diagram to illustrate an "S" reaction in which the first flexure has passed tailward and the second flexure is beginning on the opposite side. (*Coghill.*)

**The development of the sensory-motor mechanism.** The muscular system at the period under consideration consists of two longitudinal series of muscle segments, one on either side of the spinal cord. These muscle segments constitute the only functional muscle possessed until after the animal begins to swim. The behavior just described, therefore, constitutes the entire behavior pattern at this age, and the muscle segments are the only effectors in it.

We may now turn to the consideration of the growth of the nervous mechanism and see how it correlates with each stage in the development of behavior. Figure 23

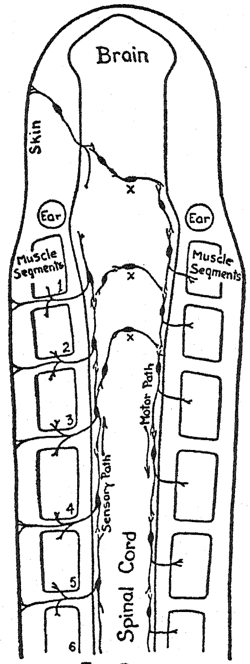



**Figure 23.—Diagram of Mechanism Which Accounts for the Coil Reaction.** (*Coghill.*)

is a simplified diagram of this mechanism. In the left side of the cord are represented the sensory cells. It will be seen that one branch extends out to the skin and also to the muscle segments. Thus, one neurone serves for both tactual and kinesthetic stimulation.

There is also one branch which extends up the cord and one which extends down, both of which make connections with other similar neurones. In the right side of the cord are represented the motor neurones. Those neurones marked *x* connect one side with the other in the medulla. We thus have in this case a chain of

neurones which may conduct an impulse up the cord, across in the medulla, and down the opposite side to muscle segments. It should be understood that both sensory and motor neurones are to be found on both sides of the cord, but for simplification each group is omitted on one side.

Coghill has made detailed studies of the nervous system of amblystoma at each stage in its behavior. His findings may be briefly summarized:

> 1. *Non-motile stage.* There are at this stage both sensory and motor neurones, but the connection between the sensory and motor systems is incomplete.
>
> 2. *Early flexure stage.* The neurones in the medulla $(x)$, which up to this time possessed only one branch, become bipolar and complete the connections between the sensory neurones of one side and the motor neurones of the other. It is found, accordingly, that the movements of the embryo in this period are typically away from the side stimulated.
>
> 3. *Coil stage.* The neurones described are fully developed only in the anterior end. As the development progresses tailward, the flexure is extended until the coil is effected.
>
> 4. *The "S" stage.* Two factors play a part here: *a.* As the muscle segments contract, sensory branches in these segments are stimulated, and this impulse is transmitted to the other side, to the first segments, and progressively tailward. *b.* The axones and their collaterals become greatly elongated, and thus make connections with a greater number of neurones along the cord, facilitating the transmission of the impulse.
>
> 5. *Locomotion.* There is a growth of collaterals from axones of the anterior part of the motor tract into relation with the dendrites on the floor plate cells $(x)$. These collaterals cause an excitation that is on its way to the muscles of one side to be carried

through these commissural cells of the floor plate to the motor system of the other side. In this passage to the muscles of the opposite side, more connections are involved than there are in the path to the muscles of the same side, so that the second flexure follows the first by a very brief interval (Figure 24).

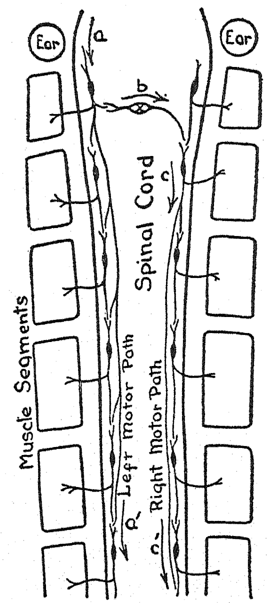



**Figure 24.—Diagram of the neuromotor mechanism of swimming.** The sensory mechanism is omitted. (*Coghill.*)

**Necessity of structure.** Coghill has demonstrated in these experimental studies that the neuromuscular structural relations used in the act must exist before the act is performed. Accordingly, the experience of the animal with reference to the outside world appears to have nothing to do with the determining of the form into which the behavior of the animal is cast, whereas experience in relation to the environment has much to do with the

determination of *when and to what extent* the potentiality of behavior shall rise into action.

Another fact which he emphasizes is that comparative embryological studies show that the higher the animal is in the order of intelligence, the greater is the *neural overgrowth*. This was previously suggested in connection with the description of the cerebral hemispheres in the human brain. Coghill finds that the increase in complexity of behavior of the amblystoma beyond the swimming stage is paralleled by an increase in the number of neurones in the brain beyond those actually constituting the neural circuits involved in any specific type of reaction.

**Effects of delayed activity.** It might be objected that Coghill's experiments did not prove conclusively that the amblystoma's behavior was due alone to growth of the nervous system and not to experience through the stimulation of its environment. Amblystoma and frog tadpoles which were isolated from stimulation of the environment have been studied.[2] Some time before these embryos had reached the stage of the first movements, they were placed in a solution of chloretone, which anesthetized the receptors but did not interfere with normal growth. Five days after a control group began swimming, the drugged specimens were removed to tap water. The object of this procedure was to wash out the anesthetic. The first movements were evidenced in an average of 12 minutes, and within the next 30 minutes several specimens swam as well as those of the control group. Table IV gives the time in minutes required for the first movements by sample specimens.

[2] Carmichael, L., "The Development of Behavior in Vertebrates Experimentally Removed from the Influence of External Stimulation," *Psych. Rev.*, 1926, Vol. XXXIII, pp. 51-58; 1927, Vol. XXXIV, pp. 34-47.

TABLE IV

TIME IN MINUTES FOR FIRST MOVEMENTS IN DRUGGED TADPOLES

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Amblystoma ........ | *Minutes* | 14 | 25 | 9 | 7 | 6 | 8 | 8 | 7 | 24 | 13 |
| Frog Tadpole ....... | *Minutes* | 10 | 14 | 11 | 7 | 9 | 15 | 15 | | | |

One might ask whether the lapse of time before movements were observed in the drugged tadpoles was due to the time required to remove the anesthetic, or whether it did not represent a partial preliminary adjustment to the stimulating environment. This was answered by the anesthetization of specimens that could swim, and it was found that the time required for first movements when these specimens were transferred to tap water was practically the same as for the first group of drugged specimens. It is clear, then, that Coghill's conclusions are correct. The type of behavior exhibited is dependent upon the neuromuscular structure possessed by the animal.

**Human prenatal behavior.** Similar observations have been made of the behavior of kittens and human infants prematurely born. It was found that at a very early stage of development they would react to light pressure. These first reactions took the form of a bending of the trunk and neck by mass movements as well as movements of the limbs. At a later stage, movement of the arm alone could be elicited by stimulating that member, but the legs still moved only as a part of the mass movement. Finally, a stage of maturation in which individual reflexes could be elicited in most parts of the body was reached. As in amblystoma, the human infant exhibited a response first to a stimulus at the head end and only later to a stimulus in the legs. From these observations

we may infer that human behavior also is dependent upon the maturation of neuromuscular structures. While most of this development has taken place before the infant is born, we shall have occasion to point out in the next chapter that there is evidence of further development after birth.

## Modifications of Behavior

While it is true that all behavior is dependent upon and limited by structure, this does not mean that behavior is fixed and immutable. Even such a lowly animal as the ant can learn to respond to new situations. Man, of course, possesses the greatest variability of response and the greatest ability to learn new responses to old situations and to learn to react to new ones. We do not know just what modification of his reacting mechanism is changed when he forms a new habit or learns a poem, but some modification must take place. When we have learned to avoid the flame, or when we have learned a definition in psychology, we are not the same structurally as we were before.

**Conditioned reflex experiment.** An interesting and instructive experiment in learning was performed by Pavlov. This was the investigation of the salivary reflex in the dog. Pavlov inserted a fistula into the dog's submaxillary gland in such a position that as the gland secreted, the saliva dripped upon a pan that was connected with a recorder and the rate of flow could be measured. When food was placed before the dog, the secretion was greatly increased, but the ringing of a bell at first had no effect. The bell was then rung every time that food was presented. After numerous repetitions, the ringing of the bell alone without the presentation of food

was followed by the flow. In this case a stimulus that did not originally initiate the response had been substituted for the original stimulus; that is, the response had been "conditioned" to a new stimulus.

Similar experiments have been performed with human subjects. Watson found that the infant would start, draw back, and cry when a steel bar was struck and a loud, high-pitched sound produced, but that he would reach for a white rat, rabbit, or dog placed before him. Watson then struck the bar every time one of the animals was presented, and the infant would give the characteristic response to the noise. After a time, the child would react to the animal alone as he had at first reacted to the noise. Presumably, if Watson had pinched the infant's foot every time the rat was near, the infant would have acquired the response of withdrawing the foot every time the rat was seen.

Occasionally there develop conditioned responses that are considered mere mannerisms. One infant always held one ear when he was nursing. He would seize his ear the moment he saw his bottle coming. It is probable that he had first grasped his ear, more or less accidentally, because of the natural position of the hand near the face, and this in time had become conditioned with feeding.

Such changes in behavior as are illustrated by the above experiments are familiar to everyone. I may enjoy a certain fruit, but on a certain occasion it makes me ill. Thereafter the sight of it is repulsive. I say that I don't want it because I don't like it any more. I was taught that snakes were poisonous and loathsome, and now I recoil from all snakes, including the harmless species.

**Mechanism of the conditioned reflex.** An explanation of the conditioned reflex may be offered in terms of the

neural mechanisms involved. We may assume that every receptor is connected with every effector (muscle or gland) through the medium of the central nervous system (Figure 25). One receptor, $R_1$, is more directly con-

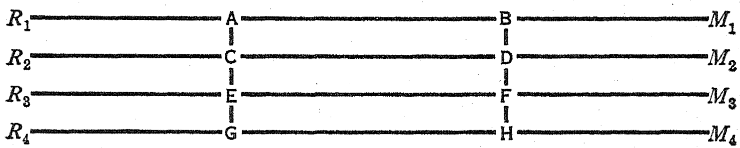



**Figure 25.—Diagram of Neuromuscular Network.**

nected with a certain effector, $M_1$, than with the others. When a second receptor, $R_2$, is simultaneously stimulated, its corresponding nerve impulse finds the path to $M_1$ already active and more open than any other. After repeated use of this pathway, $R_2$ alone will excite a response in $M_1$. We do not know what structural change has taken place in learning. One theory is that the delicate nerve endings have elongated and thus formed closer junctions at the synapse with certain other neurones. But certain it is that some change has taken place.

**Conditioned reflexes not simple.** We have described the conditioned reflex as a simple process and its mechanism as a simple chain of neurones. This is not the true picture. Pavlov found that the slightest disturbance would destroy the conditioned salivary reflex in the dog. A fly buzzing near him was enough. The dog must be retained in a definite position with little movement possible. These circumstances illustrate an important point. The response elicited depends upon the total behavior pattern of the individual. Repetition alone will not effect learning. You may read a passage twenty or five hundred times without learning it. Again, you may learn a similar passage in one reading. A great deal de-

pends upon the *adjustment* at the time. The nerve impulse of the stimulus may lead into other nerve patterns and never be conditioned to the desired response.

### Questions for Review

1. What three principles may be derived from Coghill's work with amblystoma?

2. Why is it that maturation and learning cannot be clearly distinguished?

3. Think back over some of your childhood experiences. Can you remember any situations in which your behavior was more or less permanently conditioned as a result of only one or two presentations of the situations? Observe the behavior of a younger brother or sister or other child and note any occurrences of similar instances.

4. Draw a diagram representing the structures and phenomena involved in Pavlov's conditioning experiment.

5. Give a one-sentence definition of conditioning.

6. Use the principle of conditioning to show that the autonomic nervous system is intimately connected with the other divisions of the nervous system.

7. List all the important factors in establishing a conditioned response.

# CHAPTER X

# The Genesis of Human Behavior

We have previously suggested that psychology might be defined as the study of how the infant develops into the adult. We shall, then, find our problem simplified if we postpone for the present our investigation of adult human behavior and consider briefly the behavior of the young infant. We may first examine the newborn infant's reactions to stimuli and then note the emergence of new reactions as the infant develops. Such a study should give us the principles for understanding the development of the behavior of the adult.

## The Beginnings of Human Behavior

The sensory-motor equipment of the newborn infant is not so completely lacking as is popularly believed. Yet it is a mistake to consider the infant merely a man in miniature, lacking in the powers of speech and locomotion but endowed with the other forms of activity. The popular view represents the same anthropomorphic interpretation that is commonly found in the interpretation of the behavior of the lower animals.

The infant possesses at birth, or soon thereafter, a number of quite definite patterns of behavior in response to the proper stimuli. An outstanding characteristic, however, is that these responses may be elicited by many other stimuli applied in more remote parts of the body

than those generally considered the effective ones. For example, a touch on the cheek may cause sucking movements; or the prick of a fine needle on the hand may result in a vigorous flexion of the leg.

**Vocalizing.** When the infant is first taken from the mother, the "birth cry" is almost universal. Many notions have existed as explanations of this first cry—that it is a "protest" against entering the world, that life begins with pain, and so forth. If the cry is not forthcoming, slapping, rubbing, or a dash of hot or cold water elicits the response. Whatever the stimulus, the cry is intimately associated with the initiation of breathing. The first intake of air may be a stimulus to crying.

Infants a few hours old have also been observed to sneeze and hiccough. As irritations of the mucous membranes of the nasal passages in the adult cause sneezing, it may be that similar stimulation elicits the response in the infant and similarly functions in the elimination of obstructive material.

**Grasping.** Immediately after birth, if the palm of the hand is stimulated, the fingers flex. In many instances, this flexion is so strong that if an object, such as the nurse's finger or a small rod, is pressed against the palm, it is grasped so tightly that the infant may be suspended by it free of all other support. Most of the time, the infant's fingers are closed into the palm. The thumb is usually enclosed by the other four fingers. This flexion movement started before birth. It is the result of maturation and learning. As the neural and muscular mechanisms develop, tactual stimulation causes flexion of the fingers. Thus, the fingers are brought into contact with the palm and another tactual stimulation set up. We may say, therefore, that grasping is not merely a simple reflex, but a conditioned reflex, even in the newborn.

**Sucking.** This is a complex series of responses which occurs immediately or soon after birth. The response consists of the extension of the tongue, turned up on the sides, and a contraction of the lip and cheek muscles, followed by swallowing. Under normal conditions, if the infant is hungry when the nipple touches the lips, this reflex mechanism of the lips, tongue, and cheeks is brought into action. As milk flows into the mouth, it serves as the stimulus for the swallowing response. At the same time, there may be slight movements of the head which partially adjust the infant to the breast.

It should be understood that we are using the term *reflex* rather loosely. Sucking is a complex sensory-motor response involving numerous elements which are interrelated. One response is a stimulus for another, which, in turn, may be the stimulus for coördinating the other elements in the total response. The interesting feature of the process is that these various elements are so well integrated into a complete, complicated performance at such an early age. Practically all of the improvement with repetition is to be observed in the first few days.

Here again, we find that the response is elicited not only by stimulation of the lips and mouth, which might be considered most intimately related to feeding, but by stimulation of neighboring regions. Gently stroking the cheek or even more remote areas also is followed by characteristic sucking reactions in the young infant.[1] With later development, the stimulus becomes more specific. This is quite characteristic of all the behavior of young infants. At first almost any stimulus may call forth almost any reaction pattern. Later a specific stim-

[1] Pratt, K. C., Nelson, A. K., and Sun, K. H., *Behavior of the New-born Infant,* the Ohio State University Press, 1930.

ulus is more likely to call forth only a very specific response.

**Eye movement.** In the young infant, the eyes move independently of each other. One may turn out while the other turns up or down, or they may rotate without reference to the movements of each other. In the normal adult, the eyes are coördinated in their movements. They converge, or turn in toward the nose; or if one eye turns up or down, or to the right or left, the other turns in the same direction. We may say that both look in the same direction. This is true even if one eye is closed. This incoördination of the eyes of the infant seems to be a part of the general response or random activity when no specific stimulus of vision is present.

If, however, a bright spot of light is presented near the infant's face, both eyes may turn in the direction of the light. We say that he can fixate the light. If now the light is moved slowly before his face from right to left, or up and down, both eyes may follow it quite accurately. In this case the specific stimulus seems to be necessary in order to elicit this specific reaction pattern. Rapidly, this coördination of eye movement becomes so fixed that, as in the case of the adult, one eye cannot move independently of the corresponding movement of the other eye.[2]

**The toe reflex.** A great deal of interest has attached to the reactions of the toes when the bottom of the foot is stimulated. Babinski, an eminent neurologist, noted in many pathological cases among adults that, instead of the normal flexing of the toes—the plantar reflex in these cases—the toes were extended or turned upward. This was taken as an indication of a lesion in the spinal cord

[2] McGinnis, J. M., "Eye-movements and Optic Nystagmus in Early Infancy," *Genet. Psych. Mono.*, 1930, Vol. VIII, No. 4.

which obstructed the normal reflex. This reflex has become known as the "Babinski sign." Watson[3] reported that most infants exhibit this type of the reflex, and that it persists during the first 6 months, or even longer. If this were taken literally, it might be good evidence that the neural patterns of the infant are not sufficiently developed to function in the normal reflex, just as it is understood that in adults exhibiting the Babinski sign the nervous centers have deteriorated. As a matter of fact, infants exhibit both types of response: the toes turn up as readily as they turn down, and the two types of response may alternate.

Such investigations, when completed, should be important in our understanding of the development of the adult's behavior. For example, the normal toe reflexes are an important element in the adult's walking. We also know that during the first six months of his behavior, at least, the infant shows little sign of possessing the reactions involved in walking and would not walk even were he possessed with the requisite muscular strength. The extension of the toes with plantar stimulation is a part of this lack of walking equipment.

**Random responses to stimuli.** It would be significant if we could observe that the newborn infant displayed definite withdrawal responses to painful stimuli, or that he made movements of rejection. The adult makes a sudden withdrawal of the hand when it touches a hot or sharp object. He flees from danger. If he cannot withdraw the member stimulated, he will push away the disturbing object. He fights when he cannot flee. In the infant, however, the corresponding responses are not so clearly identified as are vocalizing, grasping, and suck-

[3] Watson, J. B. and R. R., "Studies in Infant Behavior," *Sc. Mo.*, 1921, Vol. XIII, pp. 493-515.

ing. Some investigators have reported definite withdrawal and rejection responses, but others have not been able to verify these observations.

Watson found that if the foot is held so that it cannot be withdrawn and the inner side of the leg is pinched, the other foot is raised and pushed against the hand of the experimenter to remove the stimulus. Similarly, if the infant's nose is pinched, his hands are raised as if to push away the experimenter's hand. Sherman [4] experimented by pressing with his finger against the infant's chin and counting the number of arm movements made before both hands pressed against the hand of the experimenter. He demonstrated that the infant would make these coördinated rejection movements, but that they are not so definite as one would be led to believe from Watson's description. Infants in other studies exhibited still less definite defense reactions.[5]

From these contradictory observations we may conclude that the infant reacts to painful stimuli with many random responses, some of which appear to be definite withdrawal or rejection movements if we neglect the other movements. Out of making these random responses, he learns that some responses are effective in avoiding or eliminating the stimulus. This learning is on the simple conditioned reflex level of the modification of behavior.

**From general to specific response.** One of the outstanding features of all the reactions of infants that have been described in the preceding pages is that the very young infant exhibits a rather *general response,* or mass

[4] Sherman, M. and I. C., "Sensory-motor Responses in Infants," *Jour. Comp. Psych.*, 1925, Vol. V, pp. 53-68.

[5] Pratt, Nelson, and Sun, *op. cit.* Also, Dockeray, F. C., and Rice, Charlotte, *Studies in Infant Behavior,* the Ohio State University Press, 1934.

movement, whether it be in connection with the random movement, with grasping, or with eye movement. The stimuli that elicit these responses are also rather non-specific and need not be applied to any specific receptor. With increasing age, the response becomes more specific and the area stimulated which will elicit the response becomes more restricted. In all types of behavior in a growing organism we find the same progress from the more general to the more specific.

The amblystoma, studied by Coghill, first exhibits general response; only later does it manifest specificity of response. When the legs appear, they at first move only when the whole body moves. With further maturation, the leg can move independently of other bodily movement. We shall see that the infant's behavior in manipulation, in walking, and so forth, passes through somewhat the same stages of development. A close parallel is also found in adult learning of new responses.

## The Development of Human Behavior

We have seen that at birth the infant possesses only a few fairly definite behavior patterns. During the succeeding months and years, he will attain skills that are so common to the adult human that we neglect to recognize that they are significant in human development. At birth the child possesses a complete muscular system, but his muscles are weak or immature. He has a complete set of peripheral neurones, but the correlation centers, particularly in the cerebral cortex, lag far behind. Just as this is the latest development in the history of the human species, it is the last to mature in the individual.

The development of behavior in the growing infant

cannot be ascribed solely to either learning or maturation. Both contribute to this development. All we can do is describe the behavior as it is observed.

**Manipulation.** In the first responses of the infant, the finger, the hand, and the arm activities are quite uncoördinated except for the grasping reflex. When not directly stimulated, the hands are more frequently near the face. If the infant is active, the hands move in a random fashion, to the mouth or above the head, and frequently strike the face in various places. We have seen (page 130) that the infant may, even in the first few days, push with its hands against a pain-inciting stimulus on the face, though this reaction is not well established.

Out of these casual bits of behavior we may trace the development of the highly coördinated manipulation of the adult. If, while the hand is in random movement, it comes in contact with a small object, the object would be grasped, and further random movements might carry it to the mouth. Even if the object does not come in contact with the mouth, the infant is receiving stimuli of contact and stimuli of moving muscles (kinesthetic) which are becoming conditioned. At the same time, the neuromuscular system is maturing. These two factors, maturation and practice, cannot be adequately separated in our analysis. Add to these contact with the mouth and the consequent sucking reactions, and you have the beginnings of coördinated movements.

**Eye-hand coördination.** Furthermore, the object may be seen; that is, it may stimulate visual receptors, which stimulation leads to the further conditioning of the eye-hand coördination. These various factors—tactual, visual, and kinesthetic—are consequently being organized into the control of movements.

At first there is no definite reaching for objects. The sight of the object may lead to random movements of the arms, as well as of the rest of the body, and these random movements may bring the hand into contact with the object. The playful activity of handling and seeing leads to the more definite reaching and grasping movements. The activity gradually becomes more confined to the precise movements, and the random movements drop out.

At a still later date, the infant will reach for objects that are outside his range of contact. If they are already familiar or attractive, he may extend the reaching movements so far that he topples over, if he has been sitting alone. The reaching may continue while he lies in this sprawling position, but there is no progress at this stage of his development in the form of crawling or other locomotion.

**New eye-hand coördinations in adults.** The development of eye-hand coördination in adults is illustrated by numerous acquisitions of habits, such as the use of tools, or the skill of the dentist or surgeon. In the laboratory the experiment most easily conducted is the requirement of movements opposed to those most frequently made with reference to the object as seen. For example, if prisms are placed before the eye so that all objects appear displaced a given amount to the right, and the subject is instructed to raise his right hand quickly and touch a vertical line placed at arm's length directly in front, he will raise his hand as much to the right as the displacement. As his hand comes into the field of vision, that also appears displaced to the right, and it is necessary for him to move it to the left to touch the line in spite of kinesthetic cues which report that the first movements should have been correct. With repeated

trials in rapid succession, the error of movement is diminished until at the end of about 30 trials the hand is carried directly to the line. If now the prisms are removed, the error appears to the left of the line, but it is more quickly eliminated.

At the beginning, the adult subject comes to the experiment with definite eye-hand coördinations already established. The relation between the visual and kinesthetic cues is upset by the prisms. The formation of the kinesthetic responses with the new visual stimulation, that is, with a different retinal area, must be established. This situation is also illustrated by the mirror drawing experiment, in which the subject is required to trace a figure while viewing the hand and figure in a mirror.

**Hand preference.** In the early stages of manipulation, the child shows little or no hand preference. He will pick up a block as readily with one hand as with the other. For this reason, parents, noticing that the child uses the left hand but neglecting to observe that he as often uses the right, worry for fear that the child is left-handed. As time goes on, one hand or the other gains preference. Since most persons are right-handed, we are prone to seek an explanation for this preference.

Numerous theories have been proposed, some based upon social and some upon biological data. The most acceptable theory assumes that right-hand dominance is correlated with the dominance of the left hemisphere. In cases of lesion in the corpus callosum (the band of axones which connects the two hemispheres), it is found that the individual retains normal control of the movements of the right side of the body but that the control of the left side is diminished. This would indicate two important functions of the left hemisphere: namely, that

it controls the right side of the body, and that it also exercises some control of the right hemisphere. Thus, the lesion, which cuts off communication between the two hemispheres, results in the diminished coördination of the left side of the body because the dominant left hemisphere cannot function in these movements. In the case of left-hand dominance, it is assumed that the right cerebral hemisphere dominates, and that thus it exercises a more perfect control over the left side of the body as well as partial control over the left hemisphere.

Opposed to this biological theory is the social theory that we learn to use the right hand because most of our associates do and because many tasks are so set up by society that it would be awkward to perform them with the left hand. Scissors are made to be used with the right hand. The style of script letters makes it easier to write them with the right hand. It is explained that those who persist in being left-handed simply have failed to learn correctly.

This theory, that we learn to be right-handed, gains some support from the fact that most of us do use either hand, depending upon the task. At the table we may use the knife with the right hand and a fork with the left. Some men hold a cigarette in the left hand but a pipe in the right. When both hands must be used, which is the dominant one? Some right-handed women hold a dish in the right hand and use a spoon with the left, while other right-handed women reverse the operation. Many right-handed ball players bat "left-handed."

We may then conclude that both these theories are partially correct. It is necessary or convenient to develop greater skill with one hand. For most of us and for most one-handed tasks it is easier, because of struc-

tural differences in the two sides of the body, to develop right-handedness, while for a few the left hand is more easily trained.

**Locomotion.** The typical infant exhibits a series of locomotor activities, grading through crawling, creeping, and finally walking upright.[6] The first stages are occasionally omitted or greatly abbreviated. When the infant reaches for objects and tumbles over on the floor, he has begun his locomotor development so far as the conditioning of responses is concerned. In reaching for objects while lying on the floor, he may roll over. This may, or may not, bring him nearer the object. Stretching or vigorous reaching resembles the early stages of crawling.

Usually, however, the legs play little part in the crawl at first. The hands and arms seem to be the most important. Before the infant can crawl, he may raise his head and shoulders by means of his hands and arms. The result of this procedure usually is to push him backwards away from the object, but nearer some other object. This combination of tumbling, rolling, and crawling makes up the sum of his locomotor activity. If at this time the infant is stood upon his feet, he stands upon his toes with his heels well off the floor, when he supports his weight at all. If he is tilted forward slightly, he may lift both feet at once. The alternate movement of the legs develops later through a series of rather uncoördinated movements.

When creeping begins, the legs serve little purpose save as a partial support for the body, though some infants get the knees under their bodies earlier in the process than others do. The crawl gradually develops

[6] Burnside, L. H., "Coördination in the Locomotion of Infants," *Genet. Psych. Mono.*, 1927, No. 2, pp. 279-374.

into creeping. Soon after creeping is fairly well organized, one foot frequently will be brought forward and, naturally, to one side. This may develop into a new type of locomotion. One infant was observed to swing his body between one foot and his hands, thus traveling at a good rate of speed.

Frequently, both feet are brought into operation and the infant travels on his hands and toes more easily than he could upon his knees. If in the early stages of creeping the infant is balanced upon his feet and supported by the hands, he will walk, but his gait will resemble that of the tabetic. His legs shoot out to the side or too high. Week by week, it will be seen that the coördinations improve until he is able to walk without support.

**Odd types of locomotion.** Hrdlička [7] collected a large number of anecdotes regarding children who run on all fours like the lower animals. Though this resemblance to the lower animal's mode of locomotion is rather striking, it should be recognized that the human infant adopts this method only accidentally, and not because he is passing through a lower animal stage. One infant sat with his right leg drawn close to his body, the left leg extended to the side, and both hands on the floor to his right. He would then swing between hands and left foot, extend hands and foot forward, and swing again. He could travel by this method as rapidly as could another infant by creeping.

Another infant sat upright and hitched along by flexing first one leg and then the other. She would use this method even after she could walk upright, apparently because she was still a bit unstable in the upright position. Sooner or later the child learns to walk upright

[7] Hrdlička, Ales, *Children Who Run on All Fours,* New York, McGraw-Hill Book Company, 1931.

because his skeletal structure is such that this is finally the easiest and most satisfactory mode of locomotion, and also because it leaves the hands free for other functions.

There are reported some infants who never "learned" to walk, but one day got up in the middle of the floor and started off. Just how much the development of the neuromuscular system and how much learning or conditioning have to do with the adjustment to walking has not been accurately determined. It would appear that here again we cannot distinguish between those factors due to maturation of the neuromuscular system and those due to the effects of practice or learning. Both are important.

**Analysis of walking.** The sensory-motor processes involved in walking are very complex, and we can indicate only a few of them. An object at a distance is the visual stimulus which through reaching, crawling, and creeping has finally led to the more efficient walking response. Later, other stimuli set up the same response.

But the walking process itself involves a mass of sensory-motor responses that have become so coördinated and are so complicated that it is next to impossible to describe them. The pressure of the foot upon the floor initiates a group of sensory responses which lead to muscular contractions that preserve balance. These contractions of muscles become associated with the impulses from the semicircular canals. As the body swings forward in walking, the stretching of the tendon Achilles and the pressure on the ball of the foot stimulate receptors that lead to motor responses. The patellar reflex is also involved.

Therefore, not only efferent impulses from the cortex down the pyramidal tracts, but also afferent impulses

from proprioceptors are important. We may assume that the basis of walking is in the inherited connections of the nervous system, but that this basis is further conditioned by experiences of the individual.

**The mechanism of vocal response.** The organs of speech are more complex than is generally appreciated by one who has not studied these mechanisms, involving not only the vocal cords and tongue, but also the whole diaphragm, mouth cavity, and nose as well. The vocal cords, which more nearly resemble two lips, are located in the larynx, one on either side. The sound is produced by the vibration of these lips as the air from the lungs is forced between them when they are contracted or drawn together.

The lungs, however, act as a resonating chamber as well as a bellows, thus amplifying the sound and giving some of the voice quality which distinguishes one voice from another. The vocal cords simply supply a complex of vibrations, or noise, and it is by means of a system of resonators that these vibrations are properly amplified to produce the many sounds that are combined into speech and later into spoken language. The pharynx and nose are rather constant resonators, except that the air forced through these may vary and hence their importance be greater in some sounds than in others. The greatest variability comes through the changing form and size of the mouth cavity.

**An artificial larynx.** The importance of these resonators is forcefully illustrated by a recent invention to be used by persons who have suffered the destruction of the larynx. Usually, there has been inserted into the trachea below the larynx a tube through which the person breathes. To this is attached a rubber tube leading to the "artificial larynx"; this tube resembles an ordi-

nary briar pipe, of the Dawes variety, the stem of which is held in the mouth. Within the bowl of this is a thin ribbon of rubber.

Of course, the subject had previously learned to talk. Now, as he speaks, his lungs expel the air in the same controlled manner as do those of a person with a normal larynx, and his mouth cavity and lips are formed naturally. The result is the vibrating of the rubber ribbon and the proper resonance of the mouth, so that the words produced are practically as distinct as those uttered by the normal larynx. The chief difference is that the artificial larynx produces a monotone, while the pitch of the normal larynx may be considerably varied.

**Development of speech.** We have already referred to the first cry of the infant, which is rapidly developed into a distinct cry that seems to be closely associated with discomfort as the initiating stimulus. Opposed to this cry is a soft sound made during feeding. Later, the infant utters many sounds that resemble principally the vowels, a sort of crowing and gurgling that is repeated as he lies unheeded in his bed. We may presume that these sounds are due to some internal stimulus or feeling of well-being, or that external stimuli set up the response, though the exact nature of the stimulus cannot always be determined.

These vocal responses themselves set up two systems of stimuli, the auditory and kinesthetic, which initiate a repetition of the response. Through these repetitions, and probably through the development of the neuromuscular systems involved, the sounds become more definite or coördinated. One of the early developments is "mama." In one infant this occurred during a period of illness, though he certainly had never heard the word. The syllable was usually repeated several times, as, "Ma-

mamam," generally ending in *m*. Whether this became conditioned as a signal of his distress by the help of attendants is uncertain.

**Imitation in speech development.** Another factor that plays an important part here, as perhaps in all conditioning, is the social factor generally known as "imitation." Anyone who has observed a child and his attendants carefully has found that the adults frequently repeat what the child does. This affords a new stimulus to the child, for he hears his own sounds without the kinesthetic response of actually making the sounds himself. In this way an association is established between sounds made by himself and the same sounds made by another. When this process is established, it is a short step to making sounds that others make but that he has never made.

**Language.** Speech as a purely sensory-motor response should be distinguished from those responses, vocal or manual, which have a social significance as language. Many of the early responses may be considered language in this sense in that they serve as social stimuli to other individuals. The cry of "mama" may be conditioned with a state of discomfort and being cared for. On the other hand, many accurately pronounced words may be mere vocalizing. We say that they have no meaning for the child. He has merely learned to say them. Broadly speaking, language may be considered as any response that serves as a stimulus to another individual and that has been conditioned with a particular situation, though usually we use the term to refer to verbal types of response.[8]

Language, therefore, may be best conceived as a highly socialized way of dealing with objects and situations.

[8] Weiss, A. P., *A Theoretical Basis of Human Behavior,* Chapter XIII, Columbus, R. G. Adams and Company, 1929.

It is not only a form of response, but also a form of stimulation of other individuals which has many advantages over the non-verbal forms of stimulation and response. In the first place, it leaves the hands free for dealing with other objects and situations at the same time. One can talk or signal another at the same time that he is throwing a spear or using tools. This means greater coöperation of the individuals of the group who may be involved in the same project.

In the second place, language makes possible communication in the dark, around corners, and, through modern invention, at great distances. Finally, language requires less energy than would be necessary if the acts symbolized had to be performed. If the child desires something that is out of his reach, he may merely ask for it. The adult can describe a former experience, or give directions for the building of a machine, or direct the activities of a nation.[9]

**Development of language.** The conditioning of vocal sounds into a language habit is illustrated by the following example. The child first learned to drink from a glass when it was held to his lips. The word *milk* was frequently used as the glass was presented: "Do you want some milk?" In time he came to reach for the glass, which evidently meant that he wanted milk. He saw the milk, reached for it, and the glass was held for him. Later, the word *milk* evidently meant milk, even though the milk was not in sight. His wants would be more easily understood if he could say *milk*. Various sounds were made (vocalizing) which frequently led to someone's saying *milk* and getting it for him. His first satisfactory utterance in this case was *mut*. Others re-

[9] de Laguna, Grace A., *Speech, Its Function and Development,* Yale University Press, 1927.

peated it and got the milk. Soon this became a word in his little community on all occasions where milk was involved. The boy who delivered milk to the house he named the "mut-boy." This was as truly a language habit as though he had spoken properly. It was conditioned by its frequent occurrence as a stimulus with an object.

That the word was not properly pronounced but tolerated just the same is in the same class with a child's manual habits. He may use a hammer in imitation of an adult, though so inadequately that he accomplishes little save the marring of the furniture. That he may recognize his inaccuracy, though unable to correct it, is shown by his attempts to get an older person to say the word correctly for him.

Many of these words are hardly inaccurate pronunciations but new words that develop accidentally. The sound made with reference to a certain object is quickly picked up by others, and becomes a language habit. The words *dume* (good), *potish* (pencil), *shashy* (handkerchief), *hahum* (hammer), and *ponchy* (spank) are of this character, being developed by one boy and remaining a part of the family vocabulary for several years.

Much of the so-called "baby talk" may be classed as absurdities of the adult that are foisted upon the infant. If the child hears only good language properly pronounced, he will quickly develop the same type, with the limitations due to his early inability to control his vocal apparatus. A typical child brought up in this way seldom made a grammatical error or used a faulty expression until he went to school.

**Summary.** We have selected only a few of the types of response to illustrate the process of conditioning new responses. We may consider, however, that the total

behavior of the adult is a combination of responses that have been acquired in this manner. There is a modicum of heredity in that he has certain neuromuscular equipment to develop along some lines more easily than along others. He has inherited a physical organism that is adapted to the type of development that we call "human," the most important of which is the elaboration of the higher brain centers and the development of the speech mechanism and manual structure.

Through the development of language and manual dexterity, the human organism more completely dominates his environment than is the case with any other animal. If he is cold, he artificially adapts his environment to his needs by first wearing skins, then developing shelters and houses, and finally heating his dwelling.

## Questions for Review

1. Cite some familiar instances in which the lower animals have been claimed to possess human traits. What is this interpretation of animal behavior called?

2. Obtain permission from some parent to observe a very young infant. Note its behavior carefully and check the responses you observe against the material in this chapter. Try out some of the following stimuli and observe the responses: gentle stroking of the plantar surface of the foot; a slight pressure on the chin; movement of a bright object in the visual field of the infant; a slight pinch on the cheek, arm, leg, and foot; restricting general bodily activity by holding arms, legs, and head still.

3. What are some of the responses which are commonly supposed to be exhibited "naturally" by infants after they have attained a certain age, i.e., responses due entirely to maturation or growth?

4. Trace the development of a simple eye-hand coördination.

5. Suppose that you were to conduct a study of the development of handedness in adults. What criteria of handedness would you use? Why?

6. Among your own acquaintances, check the truth of the statement that changing the hand preference in children results in stuttering. Why should stuttering result from such a change?

7. Do you find any resemblance between the development of locomotion and the development of manipulation?

8. What are some of the reasons why some infants are relatively slow in acquiring habits of locomotion? What steps can be taken to speed up this learning process?

9. In what way do the principles derived from Coghill's work apply to the problem of locomotion in infants?

10. List the various sense departments involved in most ordinary walking in adults. Arrange this list in what you consider to be the order of importance of the sense departments you mention.

11. Trace the development of language in most human infants. Are there clear-cut stages in this process? What are some of the factors that may help or hinder the acquisition of satisfactory language habits? To what extent do these factors resemble those presented in answer to question No. 8?

12. Make a list of "words" which are not really words found in the dictionary but which have a meaning that is specific for your own family group and are largely carry-overs from your childhood training.

13. Give some examples of non-verbal language which are peculiar to your own particular social group and which have either no significance at all or an entirely different meaning in another social group. Can you trace the origin of some of these language forms as social stimuli?

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## SECTION IV. MOTIVATION OF BEHAVIOR



References to Student's Guide:

Exercise 31. The Relation of Activity to Food Deprivation in the White Rat (Motion Picture)
Exercise 32. Work with and without Knowledge of Results
Exercise 33. Unsatisfied Motives
Exercise 34. Modes of Satisfying Wishes
Exercise 35. Diary of Drives and Motives
Exercise 36. Analysis of "Will Power"
Exercise 37. A Diary of Rationalizations
Exercise 38. A Check List of Conflict-Revealing Items

## CHAPTER XI

# Physiological Conditions

In the consideration of stimulus-response mechanisms, one might be led to conclude that behavior is a rather limited process. We know that behavior is not so limited. At one time I react to a given stimulus with a certain specific response. At another time I may react to the same stimulus in a totally different manner, or I may fail to react at all. The stimulus is not all that is necessary to call forth a response. The stimulus is the trigger which sets off the organism. The type of response made depends upon the condition of the organism at the time. We have previously emphasized the fact that certain physiological conditions must be present before a specific stimulus will result in a specific response (page 123).

**Spontaneity.** We also observe that a great deal of activity seems to have no specific stimuli to set it off. We say that such behavior is spontaneous. The newborn infant which has been sleeping or relatively inactive begins to be restless shortly before feeding time. Young children cannot sit still long at a time, and even adults, after reading for a few hours in a comfortable chair, will get up and "stretch," or walk about. The adolescent is frequently noisy, or giggly, depending upon the sex. Some persons are energetic and have plenty of drive, while others lack ambition. Again, while some are satisfied with the bare necessities of life, others are highly

motivated to accumulate great wealth, or to strive for fame or some other remote goal. Where and what are the stimuli? We say that this behavior is due to a physiological tension, urge, or drive, or that these people possess a motive, an incentive, or a goal which urges them to act in this particular way.

**Definition of terms.** Such terms as *drive* and *motive* are often loosely employed to refer to the same condition or the same type of behavior. For the sake of a clearer understanding, it will be necessary to make some distinctions. Any physiological condition or activity which sets up internal stimulation is designated a *drive* or *urge*. Sometimes the term *physiological tension* is used. When these terms are used, we think of the behavior as unlearned and not directed toward a specific goal. Such behavior may bring about a situation in which the physiological condition is satisfied—that is, the drive is removed. Thus, if the animal is hungry, his restless behavior resulting from this internal condition may bring him to food.

*Motive* refers to the source of activity which is more directed toward the goal. If the restless or random activity of the hungry animal leads him to food which removes the hunger drive, he will learn to seek food when hungry. We go to the refrigerator late at night because we are hungry. We possess the *food motive.* Previous to this time, an observer might have noticed that we were growing restless, exhibiting the *hunger drive.* In the food motive, the food is not the motive: it is the object or goal toward which the animal is motivated. The term *incentive* is used sometimes as synonymous with *motive*, and at other times as representing the demand value of the goal.

## The Experimental Study of Drives

According to the foregoing description, all drives result in general activity, and it is only with repetition under the proper stimulating conditions that these internal conditions become associated with specific forms of response. This factor, however, is no obstacle to a tentative classification and description of some drives as fundamental to the development of human behavior. By "fundamental" drives we mean those drives that are basic or primary in the sense that they are the first manifestations of conditions of the organism which may later be the important factors in the development of other drives or motives.

**Hunger.** We have seen that the condition of hunger is responsible for varied movements of the infant which may be described as a general restlessness which persists until hunger is removed. Certain more or less specific types of behavior in the form of sucking movements indicate that there are some rather definite patterns of response ready to function. In observations made of infants, as well as of older children and adults, this seems to be the only drive which is equipped with a fairly well organized response leading to an end that satisfies the need of the organism.

It has been shown [1] that the condition we know as "hunger" is associated with rhythmic contractions made by the stomach when it is empty. To demonstrate this fact, the subject swallowed a small rubber balloon attached to a rubber tube. When the balloon was inflated to fill the stomach and the free end of the tube attached to a tambour recorder which wrote upon a revolving

[1] Cannon, W. B., and Washburn, A. L., "An Explanation of Hunger," *Amer. Jour. Physiol.*, 1912, Vol. XXIX, pp. 441-454.

drum, tracings of these contractions were recorded. The "sensations of hunger" are pretty definitely established as resulting from these contractions. It is also possible that the tissue needs promote activity more directly, as well as through the stimulation by these rhythmic contractions.

It has also been shown [2] that not only do these "hunger contractions" coincide with the subject's report of hunger pangs, but there is a direct relation between the periods of contraction and the general explicit bodily activities (Figure 26). One subject, after being thoroughly accus-

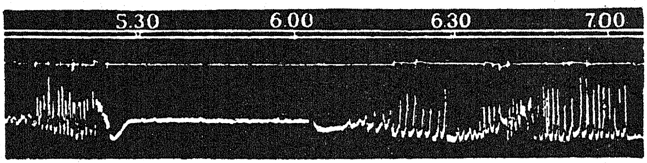



**Figure 26.—Correspondence between the periods of hunger contractions and the periods of overt bodily movements.** A sample kymograph record. Upper line: Time indicated by half-hour breaks. Middle line: Bodily movements indicated by vertical departures from the horizontal level. Lower line: Stomach contractions shown as tonus in the long level tracing, and as hunger contractions in the pronounced vertical records. (*Wada.*)

tomed to swallowing the balloon and tube, slept in the laboratory during the experiment. He had had dinner at 6:00 p. m., and the experiment started at 10:45 that evening. At 12:15 some body movements were recorded. From then on until morning most of the body movements occurred at the height of the stomach contractions. For two other subjects who lay on a couch and read all day numerous body movements were shown at contraction periods while practically none occurred during the quiescent cycles.

[2] Wada, Tomi, "Hunger in Relation to Activity," *Arch. Psych.*, 1922, No. 57.

Other experiments[3] test the effects of hunger upon white rats confronted with the task of learning to run a maze. The time required to reach the exit where the rat might or might not obtain food was taken as the criterion of the drive or motive. The rats were fed all they would eat, once a day. Six, 12, or 21 hours later they were placed in the maze. Figure 27 shows repre-

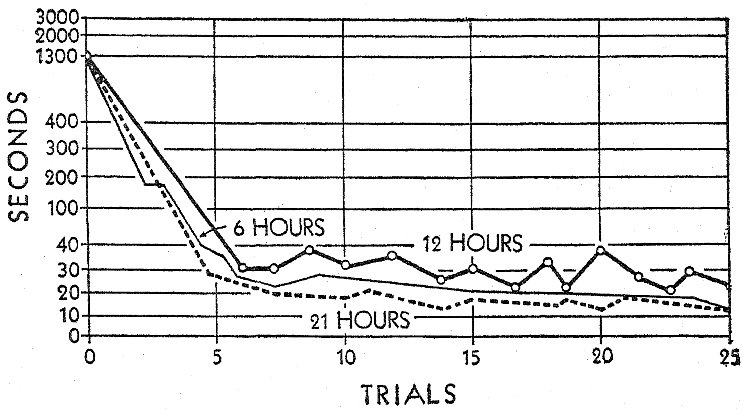



**Figure 27.—Curves of Rates in Learning a Maze for Rats Running 6, 12, and 21 Hours After Feeding.** (*Adapted from Ligon, p. 30.*)

sentative learning curves under these three conditions. It will be seen that the rats that had not been fed for 21 hours reached the food box each time more quickly than either of the other groups.

Also, just before the maze test each day, the rats were placed in a revolving cage which would measure the degree of activity of the rats in terms of the number of revolutions of the cage. The group which had been without food for only 6 hours averaged 143.1 revolutions; those which had not been fed for 12 hours averaged 121.8

[3] Ligon, E. M., "A Comparative Study of Certain Incentives in the Learning of the White Rat," *Comp. Psych. Mono.*, 1929, No. 6, pp. 1-95.

revolutions; the third group averaged 219.7 revolutions.

We may conclude that these two sets of data indicate that two separate drives were operative: the stimulation resulting from hunger contractions and the "feeling of well-being" (activity drive). This condition would account for the fact that the rats that had been fed 6 hours before the maze test did better than the second group. This assumption agrees with the statement above that the general physiological condition associated with an excess of energy is responsible for spontaneous activity. The rats which had been fed 12 hours before the experiment had begun to lose this general activity drive and were not yet sufficiently hungry to be driven to their highest degree of activity.

**Thirst** is also a tissue need which creates a drive of a similar character. We usually refer thirst to the dryness of the mucous membranes of the mouth and throat, though the need for water may be more generalized. The general depletion of the moisture of the bodily tissues that results from extra exertion may not be readily identifiable with any specific locality, yet there is a felt need for water.

**Sex.** Certain other tissue changes, particularly the development of the reproductive organs and the increased activity of the glands related to the sex functions, are responsible for the general irritability which is designated the "sex drive." While the development of the testes in the male and the ovaries in the female are generally considered the chief causes of the sex drive, other tissue changes affecting the whole organism and resulting in the so-called secondary sex characteristics undoubtedly exert an important influence. We say that the boy (or girl) becomes conscious of himself.

The same is true in the case of hunger, except that the

hunger drive develops more rapidly and culminates more readily in a specific response. The sex drive develops slowly and, aside from numerous reflexes, does not develop into a definite pattern of response that is biologically significant until much later in the life of the individual.

The characteristic manifestation of the sex drive in the youth is that he shows general irritability, but he begins also to react differently to the external stimuli, particularly with reference to those of the opposite sex. Whereas he may in the past have treated girls and boys alike, he now begins to observe differences and to behave differently in the presence of girls. The latter may be a disturbing element in his environment: he may react negatively because he finds that he cannot adjust to the new situation. He later has "his girl" because he finds that it is easier to adjust to one girl than to girls in general, and also, perhaps, because the one is a more dominant social stimulus than the others for the time being. He is also frequently overcritical of girls, even at college age. Insignificant details, dress, manners, color of hair, and so forth, are magnified in importance as against the total personality of the girl. These are merely symptoms of his difficulty of adjustment.

In addition to these visual and more general stimuli resulting from social relations with the opposite sex, bodily contacts bring new stimulations. Embracing and fondling lead to further stimulation and increase of the sex drive. Where the person is ignorant of the meaning and source of these exciting physiological conditions, such exploring alone is responsible for the completion of the sex response, which is consummatory in that it relieves the tensions. Among certain Australian tribes the function of sex is not known. Pregnancy is supposed to be

the result of touching certain trees where reside spirits which enter the body of the woman.

**Hunger versus sex.** The question is frequently raised as to whether hunger or sex is the stronger drive. Several investigations with animals indicate that if the animal is placed in such a position that he may run to food or to the opposite sex, he will choose food, provided he has been deprived of food for any length of time. It has been found [4] that rats that had been 24 hours without food would take the path leading to a receptive female only 23 per cent of the times, while they chose the food path 77 per cent of the times. Moss has studied the strength of these drives by the strength of induction shock the rats will tolerate in order to reach the goal.

A number of investigators are continuing researches of drives at the present time. They use the obstruction box shown in Figure 28. An induction current of constant intensity is used in the grid $B$. The animal is

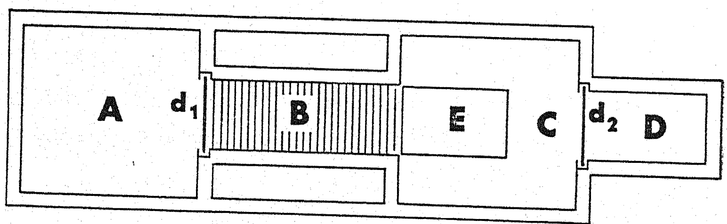



**Figure 28.—Obstruction Box Used in Measuring the Strength of Drives.** (*After Warden.*)

placed in compartment $A$ and door $d_1$ is opened. If he crosses the grid to plate $E$, door $d_2$ opens automatically, permitting the animal to reach the reward, which may be food, water, or an animal of the opposite sex. The strength of the drive is determined by the number of

[4] Tsai, Chiao, "The Relative Strength of Sex and Hunger Motives in the Albino Rat," *Jour. Comp. Psych.*, 1925, Vol. V, pp. 407-415.

crossings the animal will make in order to reach the incentive stimulus.

**Other physiological conditions as drives.** While both sex and hunger conditions serve as rather definite drives to activity which lead to the removal of the conditions, provided adequate stimuli are furnished by the environment, there are several other less well-defined conditions which also produce activity, though they are not always so easily classified. We have seen that the general tonicity of the organism, which we frequently refer to as a feeling of well-being, is manifested by general activity, often thought of as playful activity. This frequently takes the form of vocalization, for example, cooing and other contented sounds in the case of the young infant, and whistling, singing, and shouting in the case of older persons. The opposite condition of fatigue is more likely to lead to rest and sleep, though in many cases it is manifested by restlessness when it causes excessive tensions and stimulations.

Bodily temperature is another factor which displays the characteristic of the drive. A temperature above or below a certain optimum results in restlessness or general activity until the proper temperature is again restored. Likewise, internal pains, abdominal pressures, and the like may be considered tissue conditions which come under the category of drives.

**External stimulation and drives.** This raises the issue as to whether all stimulating situations should not be considered in the same category. We say that temperature is a drive when we refer to the internal condition, which, in reality, is effective only through its stimulation of certain receptors. How many receptors must be stimulated to satisfy our definition? If only a part of the body is cold, we may still refer to the condition as a

drive. In this case, can we limit the condition to the stimulation of one receptor, or at most a few, such as an area stimulated by a cold, pointed rod? The responses are very much the same in both the situation where a few receptors are stimulated and that where many are stimulated. The specific stimulus results in a response which ultimately creates an adjustment to the stimulating condition.

In a later chapter (Chapter XV) we shall see that in those types of behavior which we have chosen to call *organized response* the complex stimulating situation, involving the stimulation of several types of receptors, produces in the organism a readiness to respond to one stimulus rather than to another. This "readiness" is very similar to the tension we call the "drive." We must recognize this similarity though we retain the term *drive* for those internal tissue conditions which are responsible for the random behavior described.

**Instincts and drives.** Another question that may arise is that as to the difference between drives, or motives, and instincts. According to the descriptions of instincts given by some authorities, there is little difference. It has been pointed out (page 129) that there are no specific behavior patterns other than simple reflexes which can be considered innate adjustments to particular situations.

We may describe instinct in much the same way that we have described drives and motives. In any animal, because of his structure, there are certain tissue needs. The stimulation resulting from these tissue conditions leads to more or less random activity which brings about a satisfaction of the need. The structure of the animal determines both the physiological condition and the specific final activity which will satisfy this condition.

The brooding hen possesses physiological conditions, presumably glandular ones, which lead to "setting" on the nest. Birds "instinctively" build nests. The beaver builds a dam. The frog, when his tissues dry, satisfies his "thirst" by going into the pond or the wet grass. Some of the so-called "instinctive" behavior of lower animals is baffling, to say the least. For example, the pheasant builds a nest and remains on it the required time for incubation of the chick, but if the population of pheasants in a given territory reaches a rather definite figure, the pheasants cease building nests until the population has diminished.

We have made comparatively little progress in the explanation of this complex behavior in lower animals partly because we have been prone to refer to instinct as an explanatory principle. We have seen (in Chapter I) that naming is not explaining. In the foregoing discussion of drives, we have attempted to describe some of the immediately preceding events that culminate in certain types of behavior. It would be just as erroneous to proceed from this point and presume to explain any new bit of behavior observed simply by calling it another drive.

**Motives and incentives.** In all the preceding cases, we have shown that the drive results in a more or less general activity with little or no prescribed pattern of response. When the response has once become adaptive—that is, when a response has alleviated the condition—the behavior may become more direct with reference to the performance of this act. In this case we say that the behavior is motivated with reference to the end to be served. When he is hungry, the infant *seeks* the breast; the adult *seeks* food. The external stimulus now becomes an important factor in the motivation. In the

experiments reported, the animals reached the goal—food or mate—because of the general activity which originated from the physiological condition—the hunger or sex drive.

**Incentives.** Goals possess different values when we look at them as objects to be attained. The value of a goal lies not only in the condition of the animal but also in the object itself. Two bananas are more worth striving for than one banana. The motive resides in the animal and the goal in the object, but the incentive or goal value is a resultant of the two aspects of the situation.

**Experiment with school children.** The effect of increasing the motive is also illustrated by the performance of girls in a certain English school.[5] Each day, for 46 days, these girls were required to add columns of figures as rapidly as possible. Each girl was paid a small amount each week, and furthermore, three prizes were awarded to the three who added the greatest amount. Thereafter, each girl was awarded a prize every time she exceeded her previous best record. These prizes were increased each week: 1 penny was given the first week; 1½ pence the second week; 2 pence the third week; and so on.

Usually, practice of a function is accompanied by an increase in proficiency rather rapid at first and then less and less until no further improvement is to be observed. We say then that the limit of the practice effect has been reached. In the experiment cited, however, the rate of improvement at the end of the 46 days was as great as at the beginning. Any stipulated reward seems greater at first than it does as we become familiar with it. Since

[5] Flügel, J. C., "Practice, Fatigue and Oscillation," *Brit. Jour. Psych., Mono. Sup.*, Vol. XIII, 1928.

the reward was increased each week, its value to the subjects presumably remained constant.

Summary. We may conclude that internal stimulation, resulting from physiological conditions, tissue needs, and the functioning of glands, coöperates with external stimuli in bringing about the behavior of the individual. The organism is not a mere plastic thing, directed only by external circumstances: it is alive and active. It possesses potentialities for molding the development of motives and evaluating the objects in its environment, and for the development by the aid of experience of those remote ends and standards which we designate *aspirations* and *ideals*.

## Questions for Review

1. List the various physiological conditions which go to make up the drives in human behavior. May we assume that this same list applies to all living organisms?

2. Some plants grow toward the light; a moth may fly into a flame; an earthworm withdraws from strong light. What is the name for this type of behavior? In what ways is it similar or different from human behavior in response to drives?

3. Under what conditions would it be possible for a person who has just finished a meal to be "hungry," or for one to be "thirsty" after drinking?

4. If fed cafeteria style, a chicken will balance its diet as well as it can be done experimentally. What does this indicate regarding the nature of the hunger drive?

5. As defined in this chapter, what is the distinction between a drive, a motive, and an incentive?

6. In the study of the strength of a drive, motivation is employed. How would you justify this procedure?

7. How could you record the presence of a drive without employing a goal-seeking activity?

## Reference

Wada, Tomi, "Hunger in Relation to Activity," in *Readings in Experimental Psychology*, edited by W. L. Valentine, New York, Harper and Brothers, 1931, pp. 110-115.

## CHAPTER XII

# The Development of Motives

Most of the motives of modern man have presumably been acquired from his association in the family and immediate environment, which gradually extends to a wider sphere through the medium of language. We may, however, suppose that the motives of primitive man that we have described played a very important part in the development of his behavior. Food-getting at first was for the immediate satisfaction of hunger, but this developed into the collection of food for future use. In this case the goal, the satisfaction of hunger, becomes remote. Today we say that he is provident who plans for his future needs. Likewise the sex drive leads to the seeking of the mate, but later the mate is not merely a sex object but someone to be protected as a possession of the individual.

**Possession.** In the behavior of the young child it is possible to observe the development of the attitude toward possessions. Hunger and thirst are satisfied by food and drink. These objects may be observed to become "my" food and "my" drink. Then it is "my" cup and "my" spoon, "my" mother, "my" nurse, and so on. Toys are associated with the child's activity drives. Other objects that the child meets also become objects of possession. *Mine* becomes the word applied to all objects to which the child is attracted. It is not necessary to presuppose an instinct of collecting or hoarding

to account for these attachments to objects. These attachments are formed by what we have earlier described as the conditioned response. Some objects satisfy certain drives, but other objects also become associated with this behavior without respect to their intrinsic value.

**Shelter.** We may again presume that our primitive man was motivated to build himself a house. His desire for a permanent shelter came about through his withdrawal from pain-inflicting, or dangerous, situations. The child may find shelter and protection from strangers and other annoyances by hiding under the table or behind the chair. This does not mean that either the primitive man or the child is motivated by an instinct of shelter or flight. The drive of pain and intense cold or heat leads to the finding of means of protection or removal of the unfavorable stimulus in the case of primitive man; and the maladjustment in the presence of strangers or discomfort results in similar reactions in the case of the child.

As houses are his social inheritance, civilized man does not necessarily build his house merely because he is motivated by the primitive desire for shelter. Since he has always lived in houses, they have become essential to him through habit. This is carried so far that many people could not alter their present mode of living without suffering great hardships: to sleep in the open on a cloudless night would be next to impossible for them.

**Avoiding and flight.** We have indicated above that the child manifests fear of strangers, certain objects, and certain situations. It may be asked, Why does the child develop these fears? Is it an instinct that directs the child to flee from danger and certain other situations, such as dark rooms, furry animals, and snakes?

We must again refer to our discussion of drives and the

conditioned response. If the infant is pricked on the hand or foot, random movements either carry the stimulated member away from the stimulus or remove the stimulating object. The child soon learns to withdraw from any pain-exciting stimulus: if later he touches the hot stove, he withdraws; thereafter he may shun the stove. Numerous other experiences of this kind teach him that a certain class of objects cause pain, and by the same means he learns to avoid these objects. He also shuns strange objects because he has learned that some strange objects are harmful.

In adult life we flee from many objects and situations which we know are harmless. A student related that when he started to use a snake eight feet long in one of his experiments, it required twenty minutes of hesitation before he could pick it up, in spite of the fact that he knew the snake was harmless and he saw the owner handle it. As a child, he had been taught to avoid snakes and had habitually shunned them for so long that this response was difficult to overcome. He was not instinctively afraid of snakes: he was conditioned to withdraw from them. Such conflicts will be discussed in greater detail in the following chapter.

**Modesty and clothing.** Closely related to the motivation to get shelter is that to get protection of the body in the form of clothing. The theories of the origin of the habit of wearing clothing that are most commonly presented are those of modesty and protection from cold. To these Dunlap[1] has added the theory that clothes were first worn as a protection against insects, as clothes made of grass are worn in tropical countries. Though authorities disagree, it is quite probable that one or both of the

[1] Dunlap, K., "The Development and Function of Clothing," *Jour. Gen. Psych.*, 1928, Vol. I, pp. 64-78.

latter theories more nearly approach the truth. Many tropical peoples wear clothes though they do not need them as a protection from the cold. Furthermore, they are not averse to removing their scanty garb for purposes of swimming, dancing, or participation in athletic sports.

Whatever the original motive for wearing clothes, it is a fact that clothes assume importance through their habitual use. Not only are they worn for the purpose of protection from harmful stimuli, but they assume through custom a definite relation to modesty and refinement. In relation to modesty and the bearing upon sex stimulation, it is doubtful that the exposure of the body is very important except as it is a violation of the habitual procedure.

**Imitation and conformity.** The foregoing statement suggests another motive of social origin which has far-reaching importance in the behavior of man today. We call it "fashion," "style," or the desire to conform to the ways and beliefs of the group in which one lives. Our primitive man may have found himself confronted with the necessity of coöperating with other primitive men in order to secure food or to defend himself from the enemy. Even the tactics of the enemy would require the adoption, to some degree, of his methods.

Primitive man would also discover that his neighbors, whether friends or foes, reacted in certain ways that were beneficial to them, and these methods he would imitate. Little by little, he developed a habit of imitating first those most like himself and to a less degree those more removed in similarity. Finally, not to conform or inability to conform became disturbing and resulted in a maladjustment to the social group.

While in civilized society the necessity for conformity

does not always show itself as essential for the satisfaction of fundamental drives, we do learn to imitate at an early age. We have seen that the infant learns to imitate by being imitated and thus learns the behavior of his immediate group. He adopts the family mannerisms, language, and beliefs. He further learns that he can best get what he needs by conforming to the group. To the extent that his conformity is adequate, we say that he is making adequate social adjustments.

The imitation of the group for the purpose of securing satisfaction for fundamental drives has further consequences in that the individual develops this habit of conformity to the extent that he is restless or dissatisfied when he is unable to conform in the less important details. This is particularly evident in the problem of dress. The color of the cloth, the cut of the vest, and other little details are matters of great moment.

The same trend may also be observed in other forms of behavior. A grade of *C* is a gentleman's grade, and to win honors may be as undesirable as to be forced to wear last year's coat. One conscientious student, who was interested in his work, remarked that he found it embarrassing to get good grades because he felt isolated from his fellows.

These are, of course, only a few examples of the numerous ways in which we are motivated to conform. Most of them never occur to us as distinct problems unless we fail to conform. If we are in a group where the conversation and attitude of the others are dignified, we assume a dignified mien; if the group is carefree, we likewise become carefree and lose our stilted manner. In either case, if we are unable so to adjust our behavior, we are uncomfortable.

**Preëminence.** The habit of imitation, which moti-

vates so much of our behavior, is to some extent in conflict with the opposite motive, that of expressing our own individuality. Just as we develop a desire to conform, so do we also develop a desire to be preëminent in certain other respects.

We have seen that the child at an early age develops a dominating interest in himself. All things are "mine." While he later enlarges his social horizon, he is still largely dominated by this motive of self-interest. Hence, it is to be expected that he will strive to get for himself all the advantages possible. Man is first concerned with satisfying the inner drives of hunger and protection from harm, and later he is dominated also by the drive of the reproductive functions. He struggles with other men for the possession of food or shelter; he must compete for the desired mate. In later civilized groups, this competition applies to many other wants that have been acquired. Thus, a habit of striving to be the "outstanding man" develops as a natural consequence.

While this competition for preëminence or superiority is directly related to the struggle to satisfy some more fundamental drives, it becomes more generalized into the habit with reference to the individual as distinct in contrast to other individuals. He may no longer strive for food or for the wealth with which to satisfy his fundamental needs but may still work to maintain or gain a position of dominance in the group.

Man also has built up a desire to be recognized as an individual. His name is important to him, if to no one else. It is frequently found that men paid on a commission or piece-price basis will increase their production—or their efforts—when a competition for a prize, such as a banner or medal for service, is established, in spite of the fact that their increased sales or production at any time

would mean increased wealth with which to satisfy their needs.

During the War, millions of men were thrown together and their lives directed by the rules of the army. They were dressed in uniforms; they maneuvered "as one man"; their distinctions were quite effectively eliminated. The result was an almost universal attempt to acquire distinction. Not only were chevrons, epaulets, and medals of distinction highly regarded, but men of the ranks violated regulations in every way possible in order to mark themselves "outstanding men." A bit of ribbon would be attached to a buttonhole, a silver chain with half-franc pieces would be dangled from the wrist, or the cap would be modified contrary to specifications. Rules of conduct were also violated in many cases for the specific purpose of "being different."

Through competition and the struggle for life's existence, therefore, we build up to rival motives. We learn that we must conform to the socially acceptable standards of behavior; we learn that we can appropriate to our advantage the inventions and discoveries of others. But an opposite attitude is also developing. If primitive man's neighbor can throw a spear farther than he can, the neighbor will have an advantage. If *A* knows more than *B*, *A* will get the job or the promotion. Rivalry develops a motive for preëminence. We finally strive to conform and to be preëminent not only in regard to the essential things in our social life, but also in things that have no social value.

## The Extension of Motives

**Ideals.** So far, we have been concerned with drives and motives which are satisfied by the attainment of

relatively immediate ends. Hunger, sex, and the need of protection may lead to the establishing of motives for the accumulation of wealth, conformity to the customs and traditions of the community, and the satisfaction of other selfish ends. But man is capable of more highly developed forms of behavior. What about his ideals and aspirations for things immaterial, the social values? Here man shows his superiority to the other animals. The wolf may learn to conform to the ways of the pack. He may strive in competition to excel for the sake of the immediate rewards.

Man, on the other hand, because of the great variability of his behavior, develops motives and strives toward goals which give him no material benefit but are desirable because of the satisfaction he experiences in the behavior itself. "Honesty is the best policy" implies a motive that a common house pet can acquire. We look upon honesty in which there can be no consequences except the satisfaction of self-respect as a higher type of motive.

Let us suppose that you stop at a gas station to buy gas. The attendant makes a mistake and gives you a dollar too much change. You could drive on and he would never see you again, but you ask him to count the change he has given you. You are pleased, first by his expression of resistance and then by his expression of pleasure as he takes and counts the money. Your pleasure was not worth a dollar, but that plus your satisfaction with yourself, "the person you have to live with," was worth far more than that.

The foregoing description of an ideal hints at its origin. Honesty is forced upon us by our social life. We also learn to be fair with others, to be dependable, to pay as we go, and so forth. All of these teachings bring bene-

ficial results. But out of these we build up an ideal of honesty for its own sake. An ideal, then, may be defined as a motive with reference to a remote end.

**Altruism.** Let us take the question of altruism as opposed to the individualism we have been emphasizing in the preceding pages. We found that the child develops a notion of possession. Objects and persons become attached to the child, or his property, through the fact that his needs are supplied by them. By the process of the conditioning of responses in the securing of satisfaction of his wants, these attachments are multiplied. Those objects that are rejected as harmful form another class of objects, the class of those which do not belong to his world.

Gradually the child extends his world. To the members of his family he adds friends whom he considers as members of the family. In time the town, the school, and the country become a part of his world—they become attached. Consequently, the adult plants trees he will never see mature; he willingly supports schools, though he may have no children; he donates from his earnings to relieve the suffering of people he never sees; and he makes sacrifices for his friends without necessarily expecting any reward. We say that such an individual is public-spirited, or that he is governed by altruistic motives. Such motives are built up from more individualistic motives, but because of the habits that have been evolved they can be traced only remotely to the more fundamental physiological drives.

**Esthetic ideals.** The appreciation of the beautiful is another human trait. This capacity should not be confused with artistic techniques or the verbal pronouncement regarding what is generally considered beauty. It is

a genuine appreciation of that which is fine wherever it may be found. Some attain a higher degree of esthetic behavior than others. There is the crude way of attaining a goal, and there is the more refined method. As we progress in our level of attainment of goals, we evolve more refined methods. At the same time, we are evolving more refined ideals. The esthetic ideal, therefore, has reference to our behavior as well as to the goal toward which we strive.

**Religious ideals.** Likewise with the religious and artistic ideals or motives: aside from the more primitive aspects of religion wherein man strives to protect himself from some impending disaster or to provide future benefits for himself, in the higher types of religious behavior man develops more remote motives or ideals. We have seen that man differs from the other animals in the possession of a superior forebrain, and that in consequence his behavior is capable of enormous complexities which set him apart as unique. Starting with the bare satisfaction of immediate needs, he develops habits which create demands beyond this satisfaction of biological needs.

A reverent attitude and moral and esthetic ideals are essential characteristics of the more fully developed man. Many excellent men will declare that they do not possess these ideals, particularly the religious ideals, but it is not a question of the definitions of terms. We measure a man by the quality of his motives and ideals, not by the names he applies to them. Our only interest here is concerned with the origin and development of motives, and it has been pointed out that man, by virtue of his greater equipment, passes beyond the mere vegetative organism, to become motivated toward more remote ends which bring satisfaction only indirectly.

## Questions for Review

1. Make a list of the motives that you consider basic in human behavior.

2. Select one of the motives you consider basic and trace its development in your own experience. In some instances, this may be almost impossible to do. Why? Compare the development you have traced with that of another student. What do the similarities and differences indicate?

3. What is the essential difference between man and the lower animals with respect to the motives that are developed?

4. Distinguish between motives and ideals.

5. It has been stated that "you do what you are told to do." Check the truth of this statement by observing your own behavior for a day and noting the number of things you do which are directly traceable to a motive of conformity rather than to other motives.

6. Would it be possible to raise individuals who were entirely lacking in the motive of conformity? What sort of training would be necessary? What does this show regarding the nature of motives in general?

7. What was your motive in coming to college? To what extent has this motive been altered? To what do you attribute the change?

## Reference

Dunlap, Knight, *Civilized Life,* Baltimore, Williams and Wilkins, 1934.

## CHAPTER XIII

# Conflicts of Motives

**Choice.** We frequently find that we are in a situation in which two motives of approximately equal strength are dominant, each making a claim for satisfaction at the same time. If we act in accordance with the one, we cannot directly satisfy the demands of the other. In such situations we say that we have to make a choice, or to exercise our will power. But *choice* and *will* are names. As such they do not explain the behavior in question. We want to know why we choose the one rather than the other.

For the sake of clarity, let us assume a typical case. Miss Beta has been invited by Mr. Dana to go to a movie, and by Mr. Duma to go to a dance the same evening. She is debating which invitation to accept. She likes to dance and she knows that the party will be a gay affair, though a little more hilarious than she feels is in keeping with college ideals. Also, Mr. Duma is an excellent dancer, but not so intelligent as she would wish. On the other hand, the movie is one she has wanted to see. The leading part is taken by a grand opera star, and as Miss Beta is very fond of good opera, she does not want to miss this opportunity. Also, Mr. Dana is good company. Miss Beta is a bit bored by the persistent attentions of Mr. Duma, and to go out with Mr. Dana would be a pleasant relief. Nevertheless, she has been working hard, and would not the relaxation and gayety of the party do

her more good than the quiet, intellectual atmosphere which she would maintain about her if she went to the movie with Mr. Dana? At this point in her indecision, the telephone rings. It is Mr. Duma to say that he will call for her at nine o'clock. She says that she will be ready.

**Determiners of choice.** In this particular instance, we see that there were on each side a number of factors which apparently had equal weight. There were habits of selecting the cultural advantages, interest in music, and interest in men who were intellectually inclined. On the other hand, the young woman may have been a bit tired of the restraint imposed by study and may have wanted to break away. She liked dancing, and though she preferred Dana to the less intelligent Duma, she knew that he was a good dancer. She may have chosen to go to the dance on the basis of these factors alone. In that case, we would have to conclude that the dance motive was slightly stronger than the movie motive. But the goal of the one motive was brought a little nearer by the telephone message. The young woman made the choice, but her choice was determined by an array of specific factors consisting of habits, interests, present condition, and inclinations.

**Volition and will.** We usually say that a decision is an indication of will if we refuse to choose the more immediate goal for the sake of one more remote. Or, we may be confronted with a disagreeable task and with something we desire very much to do. If we choose to do the disagreeable task, we exhibit a strong will. If we yield to the desired activity, we exhibit a weak will. This is a reasonable inference from the standpoint of social standards, but let us examine it in the light of our knowledge of motives.

Let us assume this time that you are diligently struggling with an assignment in one of your courses when two friends burst in upon you with the announcement that they are going to the basketball game and want you to come along. You resist their arguments and stick to your determination to master the subject which you consider dull and uninteresting in comparison with the basketball game. You say that you refused to do what you wanted to do and did what you did not want to do. You exercised your will power.

Your statement is quite true, but your will power is just another name for your dominant motive. Like the girl with two optional dates, you are confronted with two conflicting motives. Certain habits and developed interests and the immediate situation, including the social stimulus of the two friends and the dullness or difficulty of the work before you, build up a strong basketball motive. Other habits and interests, a distant goal of scholastic accomplishment, preparation for a profession, a home, and business success, and the social stimulus of a professor, a girl, or your associates in general have built up a strong study motive. You *want* to go to the game, but you also *want* to attain a specific academic goal.

## Maladjustments as a Result of Conflicts

In the preceding cases of the conflict of motives in which one motive finally dominated, we have assumed that the outcome was wholly satisfactory to the individual and would be looked upon as a satisfactory social adjustment from the standpoint of social standards. Many times, however, we act in accordance with one motive while another motive is still insistent. We say that we have a guilty conscience, or that we have done

what someone else has dictated when we would have preferred to do something else. Our unsatisfied motives persist, and the result is behavior which is disturbing to the individual, or what is frequently called a maladjustment to the social situation. There are various ways in which such conflicts may find expression.

**Rationalizing.** Perhaps you went to the basketball game instead of studying. Someone comments that you were weak-willed, or you have a vague belief that it was not the thing to do. "No," you say, "I had been studying too much. Also, I need to develop the social side of my life." You also select numerous other "reasons" to prove that you acted upon a proper motive. Some of these may be perfectly good reasons, but they are not distinguished from mere alibis. You fail to distinguish between the true and the false reasons because of your prejudice. You do not face the facts.

You may also be rationalizing, or falsely bolstering your motive, when you refuse to go out "because you have to study." It may be that the social contacts are a bit difficult for you, that you are easily embarrassed, and that you study as an excuse for avoiding the unpleasant or difficult social situations. Some individuals spend their lives in seclusion because they "have work to do," or because they are ill, and never recognize that these "reasons" are only excuses. They are not so much interested in getting the work done, or they are not so ill, as they are interested in avoiding the unpleasant social experience.

We all rationalize to some extent. Some develop definite social or individual maladjustments, while most of us learn to look the facts in the face. Let me take two advanced students as examples. One was a young man who easily got acquainted with his associates. He talked

freely and easily, never bluffed, blustered, or hesitated. He was soon popular with students and faculty. If called upon to give an oral report in class, he would talk with no apparent embarrassment. He later recounted how he had been dominated by his parents as a boy. When he went to college, he was afraid of the sound of his own voice. Then he began to recognize his defect and to set about correcting it. He ceased to avoid social situations. He got into courses where he had to talk. In time, social situations became familiar to him, and now he talks with ease.

The other young man had a similar home background, but he has failed to recognize that his parents have dominated him, as well as the fact of his own social defects. He finds the "reasons" for his present behavior in other motives, principally work that does not require social contacts.

**Projection and delusion.** In our examples of rationalizing we might find that the "reasons" one discovers in accounting for his behavior lie outside himself. If you do poorly in a college course, you may seek the cause of your failure in the fact that the professor is a poor instructor. If you do well, the professor is good, but you take most of the credit for your success. We are all prone to attribute, or project, our faults or failures to others or to circumstances over which we have no control.

Some individuals are more prone than most of us to find their own faults in others. Here is a young man who is working hard to complete his studies with high standing. He is of average intelligence but lacks the normal development for the type of profession he has selected. He also possesses strong motives which are to some extent in conflict with his motive with respect to his profession. We would say that he has other interests.

These motives are toward: social prominence, a life of luxury, and a home and family before he can support them. He has been slow in getting started in his study, and consequently time is limited. As a result, he makes many mistakes. He is unable to finish all that he has started. He becomes nervous and distraught. This is the true picture.

His interpretation of his situation was different. First, he pointed out the defects in his home training. This was in part a recognition that he is in some respects incompetent, though his parents are to blame. Then he found fault with his professors. They neglect him; they find fault with him but overlook the faults of other students. He could see plenty of faults in the other students. He then began looking for defects in all his associates. Those that he found were really the faults he himself possessed but did not recognize in himself. When the contrasting views of the situation were recounted to him, he was greatly surprised to find that he had observed only one side of the picture.

In a few cases, this tendency to projection is carried to such an extreme that we call it a *delusion.* Thus, the young man whom we have just described, if he had been permitted to continue the practice of projection, might have developed the belief that some one person or institution was responsible for his failures. This belief might lead to another—that the person or institution held a grudge against him and was persecuting him. Such delusions of persecution are quite common among the insane.

It is important, therefore, when we are about to blame someone for something touching our own life to stop and examine the facts on both sides. It may be that talking over the situation with a friend or someone in whom we

have confidence will be necessary in order to get a clear perspective. If this person is unbiased and understanding and will be frank in his statements, we may discover our own weak points and how to make the most satisfactory adjustment.

**Feeling of inferiority.** We might assume that in each of the maladjusted cases with which we have been dealing there was, on the part of the subject, a feeling that he was inferior. In some instances this feeling of inferiority is more pronounced than in others. If we meet with frequent obstruction to our motives, or with a persistent obstruction to a dominant motive, we may develop a feeling of inadequacy in life situations which in time comes to dominate most of our behavior.

We all feel inferior to some extent. If you are asked to join in a game of bridge and you know the others are more familiar with the game than you are; if you find yourself in a group in which all except you are acquainted; if you realize that there is still a great deal more to be learned than you have yet studied—you feel inferior. These are normal situations and normal attitudes. Most of the suffering from inferiority endured by young men and women is of this sort, though they fail to realize that others are suffering in much the same degree. The proper recognition of this fact will do a great deal to eliminate the suffering.

Frequently, however, there are cases in which the notion of being inferior has been allowed to develop to such an extent that the individual becomes definitely maladjusted. Here is a young man who came to college several years ago. His history has been followed through college and into professional life. He was a rather short and ungainly youth, though his appearance was not unusual in any respect. He was a good student, took part in

athletics, and was a member of a fraternity. He came from a good home environment and was loyal to his father. He was particular regarding the associates he selected, especially the young women whom he chose for dates. All of this, with the possible exception of the last statement, reads like the description of a normal, well-adjusted young man. But events did not move so smoothly as time went on. The young man's behavior was at times so absurd that some thought that he was low in intelligence. Others who knew that his general intelligence was good believed he must be insane. He finally went to his instructor in psychology as a counsellor, not because he wanted a psychological examination, but because he believed that this particular man would be his friend.

Numerous conferences brought out many pertinent facts. He had experienced one of those common, short-lived love affairs, and the girl had left him for another man who was tall and handsome. He felt that because he was slight of stature, no one would love him. He did not mind if his girl friend were not beautiful providing she were intelligent and a good companion. It appeared that his stature was the basis of his feeling of inferiority. Later developments indicated that his size was not the only disturbing factor. The home environment in which he had grown up had been very strict and religious; he had learned to respect his father and his father's views. In college he had learned other views of life; he had discovered that he no longer looked upon as evil some of the things that his father considered in that light. In the end, it was concluded that his feeling of inferiority grew not so much out of the fact that he was small as it did out of his feeling of inadequacy in social situations which had its origin in an early childhood spent in a re-

stricted environment and out of a conflict between his father's and his own views of moral values.

Because this young man took the situation seriously and because he was desirous of being honest with his father, who was not unreasonable, and honest with himself, he began a program of readjustment. He evaluated his motives and practiced making adjustments accordingly. By the time he graduated, he had made some progress. Now, two years later, he seems to have lost all intense feeling of inferiority.

**Compensation for inferiority.** When one feels inferior, he may meet the situation in any of many ways. One may project the fault in the non-fulfillment of motives, or he may rationalize. He may merely act "foolish," as did the student just described. Another common method of resolving a conflict is to *compensate* for failure in one activity by vigorous activity in some other line. Thus, a boy who never was allowed to play with other boys for fear that he would learn something immoral found when he went away to school that he could not enter into the sports and conversation of his new associates. He therefore sought activities along lines in which he could excel and the others could not. As his interest in being superior grew, he became more and more eccentric. He would insist upon talking French, but if he discovered that someone in the group could talk French as proficiently as he could, he would switch to Italian.[1] You can readily recall some individual of this sort who at a gathering "puts on airs." You are justified, if you have observed correctly, in inferring that this person feels a bit inferior. We have discussed a similar case of compensation for inferiority in Chapter I.

[1] Bagby, E., *Psychology of Personality,* New York, Henry Holt and Company, 1928.

Sometimes the individual overcompensates for an inferiority. In most cases of compensation there may be a bit of overcompensation. One student senses that he is less intelligent than his fellows and in his efforts to equal them in attainment he surpasses them and becomes the scholar. Another talks loud or cynically to make himself believe that he is not inferior. The dumb beauty appears even more dumb and exercises various wiles to win attention. Not all persons who possess an inferiority overcompensate, and not all scholars or great historic personages can lay claim to greatness on the basis of overcompensation for an inferiority. This is only one form of motivation.

**Daydreaming.** One of the most prevalent methods of dealing with a conflict of motives is daydreaming. If you keep a record of hours spent in study, you should discount your total of time so spent by a large amount. A fair per cent of the time was doubtless spent in "wool gathering." Study is always difficult. Consequently, you find yourself blocked every few minutes at first by interfering activities. You switch back to the work and, the first thing you know, you are off the subject again.

Study is particularly difficult if you are bothered by some other unsatisfied motive. One young woman was failing in her work in spite of her claim that she studied faithfully. It was evident that she was becoming distressed. Any question regarding her work brought a copious flow of tears. A conference brought out the difficulty that she could not dress so well as the others, and the fact that she studied while the others went out on dates. She either received no invitations or refused them because she had to study longer and longer hours to keep up her work. Closer investigation revealed that she would study fifteen minutes and then spend an indefinite

period imagining herself in the place of one of the other girls, pretty clothes, an escort, what she would say, and so on. Supervision of her study, in which she studied aloud and did her daydreaming (which would be curtailed) aloud brought her work up to date. She also learned the proper weight to attach to frivolities and to study. At the end of two weeks, she was doing successful work and no longer wept when discussing her problems.[2]

If daydreaming is allowed to go on, it may become a substitute for the real satisfaction of motives. We sometimes say that the daydreamer escapes from reality. To meet difficulties and overcome them by making adequate adjustments is the problem of living.

**Conclusion.** We have seen that there are a great many ways of dealing with conflicts and obstructions of motives. Our methods at times may be inadequate, and this inadequacy leads to maladjustments which either leave the individual unhappy or render him a misfit from the standpoint of social standards. The best means for correcting unsuccessful behavior and for removing the conflicts is to gain a clear insight into our motives and to take the proper perspective of values and viewpoints. Most of our insight into our own peculiarities we gain through association with others. The razzing in dormitory and fraternity, the harsh jokes at our expense, and the sarcasm of instructors all help, if we can take it. Conferences, when there is a felt need, often help to get at a weakness. Two friends who frankly tell the other what is wrong with him do the trick. One should not be afraid that he will grow self-conscious by studying his

[2] For a variety of actual cases involving one kind of conflict or another, see Jastrow, Joseph, *Keeping Mentally Fit,* Garden City, N. Y., Garden City Publishing Company, 1928, pp. 271–310.

defects with a view to their correction: rather, in so doing he is on the road to self-possession.[3]

## Questions for Review

1. Why are the terms *choice* and *will power* inadequate? What sort of description is more desirable in situations to which these terms apply?

2. What are some of the factors which result in a "decision" to study rather than to attend a movie?

3. Distinguish between *rationalization* and *compensation*. What is meant by the term *projection*? What is a *delusion*; is it normal or abnormal?

4. Under what conditions may one learn to rationalize habitually?

5. What are some of the ways in which a conflict of motives may be resolved?

6. Make a list of the factors which contribute to the dominance of certain motives over others. Show that under some conditions certain of these factors are more important than the others and that this importance may shift under other conditions.

7. How would you go about helping someone to break a habit of daydreaming?

8. What steps would you take to get rid of a persistent delusion of persecution when it was quite apparent that it was preventing the person who exhibited it from making an adequate social adjustment?

## References

Morgan, J. J. B., *Keeping a Sound Mind*, New York, the Macmillan Company, 1934, especially pp. 30–133.

[3] Morgan's chapter, "What to Fight For," pp. 99–133, is helpful in suggesting specific techniques.

# SECTION V. ORGANIZED BEHAVIOR



References to Student's Guide:

Exercise 39. Organization in Visual Forms
Exercise 40. The Complication Experiment
Exercise 41. Factors Attracting Attention in Magazine Advertisements
Exercise 42. The Range of Attention
Exercise 43. The Duration and Fluctuation of Attention
Exercise 44. The Measurement of Attention
Exercise 45. Postural Adjustments in Attention
Exercise 46. Check List of Habits Revealing Organization of School Work

## CHAPTER XIV

# Observing

In Section III we have emphasized the stimulus-response relation in the development of behavior. We have seen that a specific stimulus is followed by a response of the organism in question. Again in Section IV, the emphasis has been placed upon the individual organism and its conditions as influencing the behavior that is called forth by a stimulus. In considering the stimulus and its response, we are in danger of forgetting that the stimulus is not a simple affair and that the response which follows depends upon more than simple physiological conditions coupled with a simple stimulus. We are constantly dealing, in daily life, with objects and situations. We are so familiar with these objects that we seldom stop to think that there are rather interesting psychological processes involved in our every observation of them. We say that we see the book on the table simply because the book is out there and because we are looking at it. If someone should ask us why we say that a certain man is honest, we reply that he *looks* honest, but we are unable to say why.

**The total situation as a stimulus.** When we observe an object, such as a book on the table, there are a great many factors that enter into the observation beside the mere visual stimulus emanating from the book itself. We are aware of not only a book, but a book on the table surrounded by other objects. When we observe that a

man looks honest, we are taking into consideration a great many factors which have previously in our experience been associated with an honest face—not only features of the face, but also expressive movements, the tone of the voice, and how the individual uses his hands. We have somehow learned that this is a typical situation denoting honesty.

**Confusion of terms.** Because we have learned to identify objects and situations without due regard to the specific factors that go to make up our reactions, we have developed a habit of confusing the names which we apply to these situations. Thus, we say that we can taste the orange flavoring of a cake. We have seen (in Chapter VII) that there are only four taste qualities—salt, sweet, sour, and bitter. What we "taste" in the cake is a combination of these elements and one or more olfactory qualities. The artist is prone to speak of "warm" and "cold" colors. "Cold" and "warm" in this case are referred to cold and warm experiences in which color has been closely associated. The artist consequently confuses the appearance of the colors with the temperature phenomena that he associates with them. This fact is also noted in the case of music. We distinguish between religious themes and other types of music, though there is no good reason why Händel's *Largo,* for example, should be considered a religious theme except that it originated in and has long been used in connection with religious situations.

**Wholes and parts.** We can understand more clearly the nature of the processes involved in observing if we study a few simple examples of it.

*Patterns.* If we look at Figure 29 A, we notice that some of the dots seem to form groups more readily than others. This is true because they are closer together in

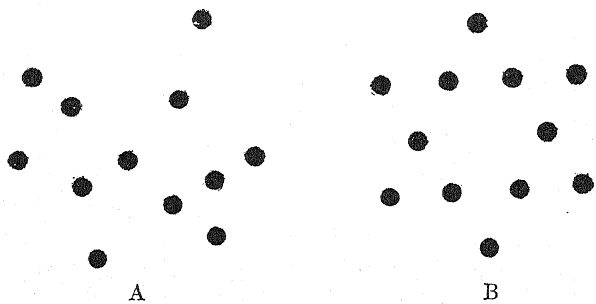


Figure 29.—Dots Are Seen As Groups.

space or because they seem to make a pattern which is easily observed. Which dots seem to us to constitute a group or what pattern they fall into depends not only upon their arrangement, but upon how this arrangement fits in with our way of observing. In other words, our previous experiences with such forms affect our observation. Sometimes the pattern of dots may be so definite that even though the dots are discontinuous, separate elements, they are seen as a pattern. For example, in Figure 29 B the dots are seen as constituting a star. It is not necessary to draw lines between the dots to make this clear; they "naturally" fall into such a pattern. Another illustration of the fact that we fill in the elements in a pattern is found by looking at Figure 33. Though only a few of the elements of the outline are given, we fill in the complete outline making a human figure.

*Familiarity.* We have learned that some things go together to constitute a unit. Thus, it would be easy at a glance to recognize "United States" as a unit, though these are two words with a total of twelve letters. We *see* it as a single object. If the constituent letters were printed without reference to any order, a single glance would reveal at best only five or six letters. A similar

phenomenon may be observed in looking for the hidden faces in puzzle pictures (Figure 30). Face forms are so familiar that it is easy to see the outlines of a face in branches and leaves when this is what we are looking for. We also see pictures of familiar objects in clouds and in ink blots. Another element that enters into the solution of the puzzle picture is the fact that we assume a sort of set, or readiness, to find the picture.

**Figure 30.—The Faces in a Flower.**

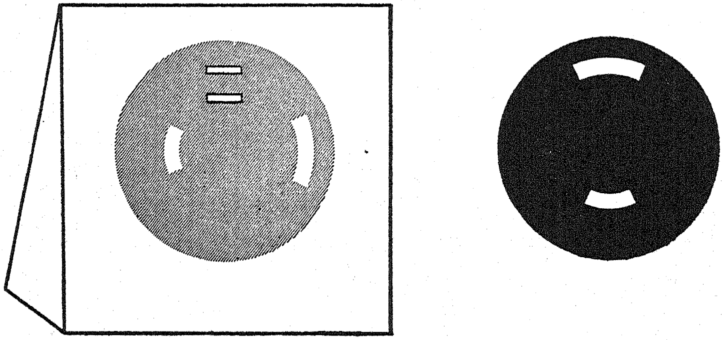
All of these cases merely illustrate the fact that what we "see" is determined by the total arrangement of objects in the field of vision and by the experience or degree of familiarity which we have with certain other arrangements. A diagonal, a circle, a star, and the outlines of a face are all familiar. If dots or lines can be drawn together into a complete familiar whole, we readily see this pattern. We do not necessarily build up patterns from simple elements. In many cases, we learn patterns first and analyze them afterwards. A child or an infant sees faces about him. He also hears sounds emanating from

objects. He touches and feels many of these objects and in other ways reacts to them. In this way he builds up specific reaction patterns which he is taught to call "mother," "father," "bottle," and so forth, without any reference to the specific elements which enter into each.

In other words, many things are learned as wholes and only later ~~analyzed.~~ When the novice unfamiliar with the workings of an automobile engine is in trouble for the first time and lifts the hood, he is nonplussed by the fact that he can see nothing but an engine. To the expert, there are a carbureter, a distributor, spark plugs, cables, and many other elements, each of which he sees in turn. When we look at a painting hanging in an art gallery, we see just a picture which is pleasing or otherwise. If we become more familiar with the principles of art, or if we study this particular picture for a certain period, little by little its constituent elements become clearer and clearer to us.

Seen movement. Another interesting illustration of the fact that we perceive the whole or organize the parts into a complete picture may be found in "motion pictures." If we observe a man walking down the street, we can see that he is swinging his arms rhythmically, that his legs move in quite smooth cadence, and that he is progressing forward at a uniform rate. In the motion picture we see a reproduction of this activity, yet "motion" pictures do not move. They are simply a series of snapshots exposed at the rate of from sixteen to twenty-eight per second. When the first picture is exposed, we start to react to it, but before we recognize it fully, the second picture is shown, and then the third, and so on. *We* move on from one picture to another. Thus, the movement consists of our continuous reaction to the series of pictures.

This principle can be shown in the laboratory. Two small holes are cut about an inch apart in a gray screen (see Figure 31 A). Behind these the disc *B* is rotated



A B

**Figure 31.—Apparatus for Demonstrating Seen Movement.**

so that white is exposed at one hole while black is exposed at the other. As the white spot thus alternates from one hole to the other, it will appear, at the proper speed of exposure, to *move* across the intervening space. This illusion of movement was discovered long before the popular movie came into existence. It was presented in the form of the "stroboscope" (see Figure 32). If a sequence of slightly different figures is placed opposite each slit, and the drum is rotated, by looking through the slits as the figures pass the eye one sees a uniform movement of the object represented.

**Observing as organized response.** What we observe or perceive through the eye or the ear or other receptors is determined by the organization of behavior which we have been able to acquire. It is sometimes said that to the infant the world is merely a buzzing confusion. It would perhaps be better to say that for the infant the outer world is nothing in particular. The buzzing con-

fusion occurs later under special circumstances which we may represent as a disorganization of response. The infant's reactions at first are what we have called "random" responses, out of which little by little he learns to

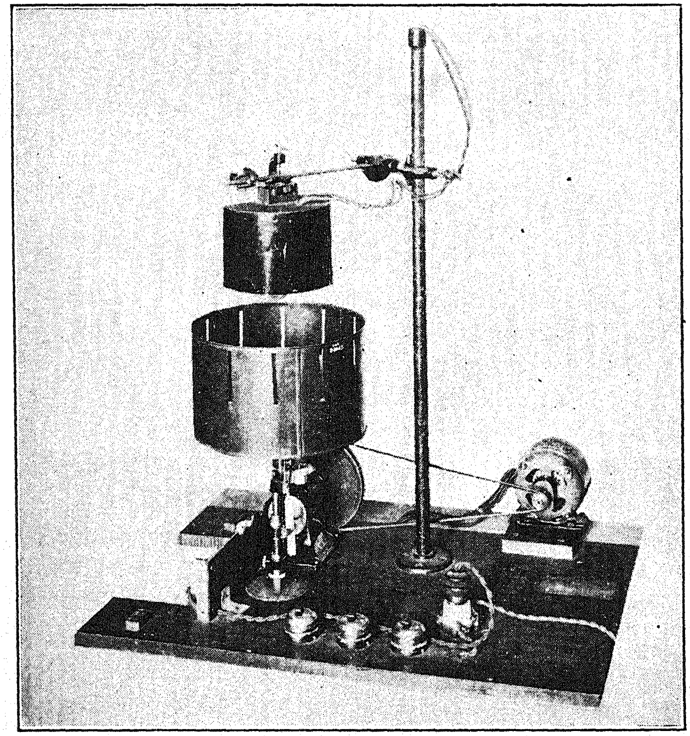


Figure 32.—One Form of Stroboscope.

react specifically to specific situations. This development of specificity of response is what we term "organization." We see and hear what we have learned through long experience to respond to in specific ways. The novice does not see the carbureter in the automobile. The man who is unfamiliar or inexperienced with outdoor life

does not see or hear what the naturalist or woodsman sees and hears. He is untrained to make the kind of responses to these situations that the one familiar with them makes. We may say that his receptors or sense organs are being stimulated but that the data from these receptors are not organized into any specific response which can be identified with any specific stimulus. The botanist can observe variations in the plant life along the trail which his companion passes by unnoticed. *Observation or perception, then, is the organization of data in the sense that what is given through receptors is organized into a pattern of response.*

**Analysis of perception.** While it is true that our behavior is governed by a pattern of stimuli which includes all the stimuli, both internal and external, affecting the organism at any particular moment, it is possible to analyze the various elements that are most important in the make-up of perception. These data may be conveniently classified as:

1. The sensory data from the object and its background.

2. Previous sensory data and previous reactions.

3. The reaction of the organism with reference to the stimuli presented.

(1) *Sensory data.* If you are asked to list the sensory data which you derive from seeing a book upon the table, you might first say that the book is red. Color is one of the elements. But the color varies in hue, saturation, and brightness, owing partly to the texture of the book's surface and partly to the angle from which you view it. Also, a certain area in the retina is stimulated. This is all the visual impression you receive. You say that the book is bound in a closely woven cloth,

and that it is rather heavy; but you do not receive the perception of texture and weight *directly* through the visual receptors. All that you receive directly through vision must be in terms of the visual properties of hue, saturation, and brightness and of the pattern of distribution over the retina. Each visual impression lasts a definite length of time, so that it may also be said to have the property of duration.

(2) *Previous data.* Further investigation will reveal that this book, or similar books, and other objects have been seen before. These objects have been touched, handled, read, smelled, and, where possible, tasted, and the impressions obtained from these experiences have involved other receptors beside the visual. You "see" that the book is heavy because of previous kinesthetic and tactual impressions. You "see" that it is rough because the particular visual impression has been experienced with the tactual impressions of roughness. The light reflected from the surface is similar to that which has come from rough objects before.

Thus, we find that previous experiences have become organized to such an extent that it is difficult to analyze the separate elements. This fact is particularly evident in the case of vision. All sorts of characteristics are ascribed to visual impressions. What is true for vision is likewise true for every other sense department, for example, in the case of "tastes" which are a combination of gustatory with olfactory, tactual, and temperature impressions: it is erroneously believed that the whole combination is a matter of simple gustatory reactions. Other perceptions involving combinations of the various sense departments will occur to the student.

As a matter of fact, these experiences have occurred so many times in the history of the individual that it is

not exactly descriptive of the actual conditions to speak of the *combination* of various sense departments. These sense departments are more intimately related than the word *combination* intimates. It is only when we stop to analyze the situation that we conclude that weight and texture are not essentially of a visual nature but must have been conditioned with strictly visual stimuli.

Our ability to separate a common "taste," such as the taste or flavor of coffee, into its strictly gustatory, olfactory, tactual, and thermal derivatives is not as far developed as is our ability to analyze the factors in the visual field. Even after long practice, the results of such analysis are not as clear-cut as analyses in the visual-tactual-kinesthetic field.

(3) *Reactions to the situation.* In the third place, the bodily adjustments which are made with reference to the object are an integral part of the perceptual process. The more specific adjustments may include that of the sense organs concerned. In the case of our illustration, the turning of the eyes, which gives a clearer view of the object, and the focusing of the lenses are important factors. General bodily adjustments, such as a turning of the head and the contraction of muscles, are intimately associated with the object. Laryngeal movements, breathing changes, and changes in the general tonus of the whole organism form the background of the whole process.

**Illusions.** The "size-weight illusion" is an example of the interdependence of the different reactions. If two cubes, whose dimensions are respectively 3 and 12 inches, are of equal weight, the smaller will be estimated to be from two to five times as heavy as the larger one. This is a good example of the interdependence of the several factors. In this case, the kinesthetic and tactual impres-

Figure 33.

sions have been influenced by the visual. Smaller objects are more often lighter; hence, our muscular adjustment is for a lighter weight, and as a result we overestimate the smaller object and likewise underestimate the larger one.

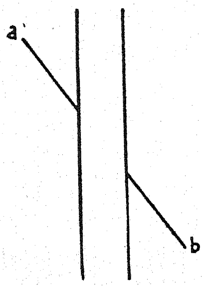



Figure 34.—The Illusion of the Broken Line.

Another typical illusion is shown in Figure 34. The line *b* does not seem to be a continuation of the line *a*.

If a straight edge is placed along these two lines, it will be seen that actually one is a continuation of the other. This phenomenon is usually explained by saying that we overestimate acute angles and underestimate obtuse angles. We can understand how this would be true if we consider the fact that we rarely see angles as they really exist. The table top is rectangular, yet from any position that you view the table, the corners are either less than or greater than right angles.

**Ghosts.** One of the most familiar illusions is what we ordinarily classify as seeing or hearing a ghost. For example, a man had been to his physician who had informed him that he had a weak heart and would not live very long. This patient had a belief that black cats were a sign of bad luck. Some time later, as he went down into a dimly lighted cellar, he saw a big black cat with glistening eyes. It was later discovered that there was no cat present. He was greatly disturbed by this vision and believed that it prophesied that he would die very soon. If we were able to investigate the case more fully, we would find that a shadow or a glistening object was the stimulus and that, owing to his recent experiences at the doctor's office and his belief in black cat prophesies, he *constructed* the cat in this instance.

As another case, a man who declares that he does not believe in ghosts reports that he lived in a "haunted" house fourteen months, and that he frequently heard footsteps and other noises which could be accounted for in no way except by attributing them to ghosts. Even though he did not believe in ghosts, he had heard that this house contained such creatures and was more or less alert to observe them. A creaking of the timbers and other natural phenomena he could therefore easily construct into "ghosts."

Evidence that this interpretation is valid is exhibited in the following account of a similar experience which was more carefully observed. The man reports that he was asleep in a bed close to an open window. He awoke in the middle of the night just in time to see a hazy, ghostlike figure and to hear footsteps as the figure walked jauntily along the side of the bed and out the window. The apparition had the very distinct appearance of a ghost. But he was more interested in accounting for the factors which had been constructed into this sort of creature. He believed that he had actually seen something and was quite positive that he had heard the footsteps. The room was partially lighted by moonlight. As he lay wondering about the phenomena, he observed his curtain sway out into the room and then gently sag back again. It was easy to see how this could have formed the visual portion of the ghost, but how about the footsteps? As he lay wide awake pondering this question, he heard the fairly regular stamping of a horse in a near-by stable.

Though such explanations are not convincing to one who wishes to believe in ghosts, and even though he can present cases for which we have no ready explanation, there is no doubt that all such phenomena are due to the organization of data or sensory experience in the terms of the experiences, beliefs, and attitudes of the observer.

**Hallucinations.** Some people hear voices or see objects that do not exist for others. One youngster frequently struck other boys on the playground without any apparent provocation. Examination revealed that he "heard them say mean things" about him. It was found that his ears were plugged with wax which distorted sounds, and these he interpreted as strange voices probably because of experiences which had led him to be

suspicious of his playmates. Such phenomena are frequent among the insane. One patient hears her enemies in the walls of her house, another patient feels insects crawling over his body, and still another smells cloth burning. Such abnormal perceptions, in which sensory data are grossly misinterpreted, we call *hallucinations.*

## Questions for Review

1. What is meant by the statement that a stimulus is to be considered a total situation, and that we should speak of *stimulus-pattern* rather than *stimulus*?

2. List some of the situations in everyday life in which only one stimulus appears to be operating. Are these situations relatively numerous or infrequent?

3. Give some examples to illustrate the fact that "familiarity" is frequently the determining factor in what will be seen, heard, tasted, felt, and so forth.

4. Give a definition of the term *perception.* What are the various elements that are most important in the make-up of perception?

5. Distinguish between hallucinations and illusions.

6. How would you explain the fact that we often see pictures in clouds?

7. A woman who felt ashamed of her private immoral behavior complained that people stuck out their tongues at her wherever she went. How could this observation be explained?

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## CHAPTER XV

# Specific Postures

The foregoing chapter has emphasized the importance of the organization of the individual with reference to the object or situation. This organization, because of its very nature, cannot be constant, but will vary from moment to moment. The object may be present, but the individual may not react to it specifically because of other activities. Such is the case when we look all over our desk for a pen or pencil when the object sought is lying in plain view.

It is usual, therefore, to speak of attention as an important factor in what we perceive. We do not hear the clock tick until we attend to it; we pass a friend on the street unnoticed because we are absorbed in, or attending to, something else. The phraseology used in referring to attention is often misleading as to the real character of this phase of our behavior. Such statements as, "We concentrate our attention," and "We turn our attention upon an object," seem to imply that attention is some sort of force that the individual is able to shift from one place to another, as he might shift the beam of a spotlight. Such an interpretation is unwarranted.

**Definition of attention.** A more exact statement, which at the same time is more easily understood from the standpoint of the activity involved, is that *attention is the total adjustment of the organism that facilitates the reception of stimuli and the appropriate response.* Def

This statement suggests that when the organism is adjusted to one thing, it is quite unadjusted for anything out of harmony with this adjustment, and such a condition is what we find to exist. Attention to one thing always means that this thing is quite definitely reacted to, and that the other stimuli fail to arouse a response.

We do not hear the clock tick because we are adjusted to something else—the book we are reading, or the problem to be solved. If when our fox terrier is not doing anything in particular, we call his name or whistle to him, he will prick up his ears and turn his head so that his sense organs are in the best possible position to be stimulated. We then say that he is "attending."

On the other hand, if the dog is busily engaged in digging in the garden, our calls and whistles will go unheeded, and his activity, if affected at all, is increased. We say that he is not "paying attention." It is obvious that he is "paying attention," but to digging and not to whistles, names, or any other stimuli. Additional stimuli unless they are too harsh, merely serve to increase the intensity of the activity already under way. The term *preoccupation*, that is, "already occupied," has been used to describe this situation.

We cannot answer the question of whether or not the dog really does hear while preoccupied, but we know that human subjects can. That is, after having gotten an overt response, by questioning we sometimes find that the human subject is able to tell us how many times he has been called before he actually responded overtly. A story illustrates this point: While walking along the street, a man called to his friend. The friend walked right ahead without hesitation and without acknowledging the salutation. He was hailed the second time, this time louder, whereupon he turned and said, "I am sorry,

I didn't hear you the first time." He had been preoccupied, or attending to something else.

**Adjustment and posture.** How the individual will react and whether he will react at all when a stimulus is presented depend upon his *total adjustment,* or *posture,* at the moment. A pistol shot occurring while I am writing may cause me to start or jump, catch my breath, and forget what I was about to write because I have no ready response. The sprinter, on the other hand, at the command "On your mark, get set" is influenced by the preparatory stimulus, which releases responses of a definite character involving the whole bodily musculature. He becomes adjusted for a definite, organized type of reaction to the pistol shot. Long training also has made it possible for him to make the quickest possible reaction of a specified type as soon as the pistol goes off. It is worth while to note also that any other sound following these ready signals would be likely to set off this same response.

*Posture,* or adjustments, are not merely of the skeletal muscles, though we more frequently use the term to refer to the general bodily position, such as sitting erect, standing with shoulders thrown back, or crouching on the mark ready for the sprint. In the broader meaning, the term *posture* refers to the total adjustment of the organism. A student is successful in one class because he finds that the professor or the subject matter is interesting. This means that because of various circumstances he is able to make the adjustment more easily in this situation than in some others.

What we shall see and hear and understand depends not alone on the stimuli presented, but also upon our *attitude,* or posture or organization. A student who makes a poor start in a course is more likely to fail than

one who makes a good start. He says that he thought the course was quite different in character than it later proved to be. He was looking for something else, and hence failed to grasp the facts presented. This circumstance is similar to our experience when a friend calls our attention to a peculiar noise in his car. We fail to identify it because we do not know what to listen for.

**Errors due to adjustment.** The fact that the adjustment facilitates the reception of one stimulus and inhibits that of another for which we are not adjusted is illustrated by an old account of the confusion that arose in the recording of astronomical observations. In 1794, the British astronomer Maskelyne and his assistant were observing the transit of a star by the "eye-and-ear method," that is: the observer listened to the tick of the clock as he watched the star pass the line of the telescope. Maskelyne found that his assistant's results differed from his own by from ½ to 8/10 of a second. He therefore assumed that his assistant was inaccurate. Twenty years later (1816–1820), Bessel checked his own observations with those of several experienced astronomers and found that the two groups of observations differed by as much as 1.1 seconds. It was finally recognized that each astronomer observed star transits in a characteristic way. Some were adjusted for the tick (that is, listened more intently than they watched), while others were adjusted for the visual stimulus (that is, watched more intently than they listened).

**The "complication" experiment.** A simple laboratory experiment illustrates the same phenomenon. The apparatus consists of a circle on a dial marked in degrees or other convenient units. Before this, a pointer moves at the rate of one revolution per second. An invisible electric contact may be set at any position of the dial.

When the hand passes this point, a bell rings. If the subjects are instructed to record where the pointer is when the bell rings, some of them will report it some distance past the correct place, and others, about an equal distance before it. It is evident that the one group maintained a characteristic adjustment with reference to the bell; hence, the pointer appeared to lag. The other group was adjusted for the pointer, and hence the bell lagged and the pointer traveled farther before the bell was heard.

Students frequently ask why it is that we hear the bell before the pointer actually reaches the bell-ringing contact. The answer is that we do not hear it before the contact is made, of course. We are merely slow in seeing the pointer, since when we are adjusted for the bell our seeing of the pointer is inhibited.

**Facilitation of response.** Viewed from another angle, *attention is the total adjustment of the organism that facilitates the response,* though, of course, the reception of the stimulus and the response cannot be separated. This relation of the adjustment to the response is readily seen in our inability to respond adequately in situations that are unfamiliar, where habits have not been acquired, and in our confusion when the conversation in a group is suddenly shifted to a subject that we did not expect. The sprinter in the hundred-yard dash must be ready to start with the gun. The batter strikes out because he expected a high ball and gets a low one.

Slips of speech are also interesting examples of lack of adjustment to the subject under discussion, or of an insistent adjustment to something else. In an after-dinner conversation over politics, when the guest remarked that Roosevelt would give a man a square "meal," he substituted *meal* for *deal* because he was still adjusted to the unsatisfactory dinner supplied by his host.

## Behavior Related to Attention

It is frequently remarked that we can tell what another is observing by the expression of his face and his general posture. We assume that the student who is looking out of the window is either attending to some object seen outside, or is dreaming, or is essentially asleep. At least, he is not attentive to the lecture.

Such external signs of attention are sometimes referred to as the expression of attention, or as the mere motor accompaniments of attention, though not an important part of the attention itself. Any behavior that can be observed by another may be considered expressive, though it may not always be accurate. Though some movements may be considered merely expressive in the sense that they are a form of language, the major portion of the movements involved in attention are an integral part of the attentive response.

receptors

Primary or universal movements. The turning of the head while listening to a faint sound and the turning and convergence of the eyes upon the object to which one is attending are primary movements and hence important in the total adjustment. Many muscular contractions, through their association as a part of the adjustment, are related to attention though they are not necessary in the sense of bringing the object to the receptors concerned. The student at his work finds that his whole body is tense. He usually regards it necessary to sit erect at his table in order to study efficiently, though a reclining chair would theoretically do just as well. That this

2. body tension

is so is partly due to previous methods of dealing with similar situations, though a certain amount of tension seems to be a necessary part of total adjustment. In all

acts of attention, the total organism seems to be involved.

There are also *respiratory* and *circulatory* changes related to attention. Measurements of the rate and extent of breathing indicate that with the adjustment to a visual stimulus, breathing is shallow but more rapid; while it is indicated that with an auditory stimulus, the depth of breathing is increased but the rate is slower. The steadiness required in fixating the visual stimulus is supposed to require the shallow breathing, which is compensated by the increase in rate. With auditory stimuli, the slower rate is a primary adjustment.

The circulatory changes involve an increase in heart rate, a constriction of the peripheral blood vessels, and an increase in blood pressure. To what extent these changes are similar to the respiratory and circulatory changes that occur in emotion has not been clearly demonstrated, but it seems probable that the two types of changes are of the same order. The difference between the two types of behavior lies in the fact that the one is a relatively complete, organized response while the other is typified by disorganization.

**Secondary or individual movements.** Still other movements may have no particular place in attention, except that they have been conditioned with it. They may be considered secondary movements, as distinguished from those contractions that are seen to have some direct function in the total organization. Frowning, rubbing the chin, and pulling the hair when one is perplexed or is solving a problem are secondary in the sense that they add nothing to dealing with the situation or object, although they may have become so integrated in the act that they persist in all such situations.

These are chance movements that have occurred with similar situations and have never been unconditioned

because they do not interfere with normal adjustment. That this is so is illustrated by the case of a boy who was competing in a spelling match but was beaten every day by another boy. He finally noticed that this boy always played with a button of his coat when spelling a word. He managed to cut off this button and thereafter spelled down his rival.

### Conditions Affecting the Adjustment

Whether objects and situations are properly perceived and the degree of precision of discrimination depend upon numerous factors or conditions. These factors may be classified, for instance, as follows:

I. The environmental factors; those relating to the stimulus or object:

1. Intensity of the stimulus.
2. Duration of the stimulus.
3. Movement, continuous or intermittent.
4. Size of the stimulating object.

II. Personal factors; those relating specifically to the organism:

1. Inherited structure of the organism.
2. Training, habit, or previous experience.
3. Immediately preceding activity or previous adjustments.
4. Social factors.

It should, however, be clearly understood that these two classes of conditions are never effective independently of each other. We may react to a loud noise, but we would not so react if it were not for the fact that certain conditions of the organisms—such as habit, preceding activity, and so forth—coöperate with this stimulus.

**Environmental factors:** (1) *Intensity.* The strength of the stimulus is an important factor in adjustment, though, as has already been intimated, it is effective through the coöperation with the personal factors. A loud noise or a bright light is more effective, other factors remaining constant, than a weak stimulus of the same sort.

(2) *Duration and repetition.* These also enhance the effective strength of the stimulus. A loud, cracking noise in the radiator may be noticed at once, but one of moderate intensity may persist for some time before it has any apparent effect upon us. In the laboratory, it is found that a weak auditory stimulus (liminal stimulus) may not be heard if it is continuous; but if it is made intermittent, it at once becomes audible. The intermittent alarm clock and the blinking signal lights at the railway crossing are familiar applications of this principle. The stimulus in these cases seems to be rendered more effective because of the contrast between it and its background—between the sound and the silence or the light and the darkness.

(3) *Movement.* We see an object more readily when it moves than when it is at rest. This characteristic of perception is so pronounced that many animals when in danger seem to rely upon remaining motionless as the effective method of concealment. Movement is used in electric signs to catch the eye of the public. The flag of the watchman at the railway crossing may not be seen unless he waves it before the approaching driver.

Like the intermittent stimulus, the moving stimulus is effective by virtue of the fact that movement enhances the contrast beween the object and its background. As a stationary object, it fits into the pattern of the whole background as a single unit. In motion, it changes the

pattern on the background. The effect may also be due to the fact that the moving object stimulates more receptors in the organism and thus has an effect similar to that of a large object.

(4) *Size*. To what extent the mere size of an object is effective is difficult to estimate. A full-page advertisement, other factors remaining constant, is more likely to be seen than an advertisement that occupies less space. If one runs hurriedly through the pages of a magazine and then attempts to recall the articles advertised, he will find that those of the larger advertisements predominate in his recollection. On the whole, the larger objects may be considered to be effective because they stimulate a greater number of receptors.

**The personal factors**: (1) *Heredity*. It is difficult to assign a specific value to the influence of heredity in the development of specific types of behavior, such as attention, because it is always interwoven with the effects of training. So far as the growth of the neuromuscular system is concerned, however, we may assume from the evidence at hand that there are two general problems involved, one dealing with individual differences in general ability, and the other dealing with the possibility of special abilities. There are gross individual differences in general ability that can be quite clearly demonstrated—cases in which the individuals investigated have been surrounded with the same, or nearly the same, physical and social environment. These differences must, then, be considered due in greater part to differences in the natural capacities of the individuals.

When we turn to the more specific capacities, such as the ability to discriminate the difference between two tones, the ability to distinguish two colors or weights, or the ability to use the hands in some act of skill, it is not

so easy to say how much is due to heredity and how much should be ascribed to special training. Defects, such as deafness or color blindness or neuromuscular defects that make movements less accurate, must be granted as often the result of heredity and the growth of structures. There may also be inherent differences that make it easier for one person to learn music, for another to learn art, and for others to become proficient in science or literature.

Seashore has shown that tests of musical talent applied to untrained subjects will predict future success. Tests applied to beginning typists or other vocational groups have been found equally effective in prediction. The most that we can say is that every individual inherits a certain neuromuscular equipment. Certain types of occupation seem to demand a specific type of neuromuscular mechanism. Others demand different types. But these mechanisms are so readily modified through training that the differences are relatively of little importance in most cases.

(2) *Training.* As perception is largely a matter of conditioned response, previous experiences of the individual with the object or situation will determine to a large extent the adjustment that is made by him in any particular situation. The architect will note the artistic features of the cathedral while to others it is merely large, costly, or cold and damp. The infant reacts to all furry animals in much the same way. Later experiences with different kinds of animals produce a differential response: the rabbit is a gentle animal, while the cat is an animal that scratches. In the same way, the student in the laboratory may fail to distinguish between two tones of nearly the same pitch, but with continued practice he can distinguish much smaller differences.

The relation of training to attention is seen in the case

of emotion, a condition in which the organization is broken up. The structural steel worker is capable of walking the steel girder of the tenth story and even takes unnecessary risks. The difference between his behavior and that of the man unfamiliar with such situations lies in the very fact of familiarity or habit. His adjustment has been perfected through the repetition of such performance.

Emotion, then, may be said to be opposed to attention. For this reason the testimony of eyewitnesses of a crime or accident may not be valid. What is "seen" under conditions of emotion may be very far from what actually takes place. If one were habituated to scenes of violence, he would be more able to adjust to the situation than would otherwise be the case, and his testimony would be more reliable.

The city dweller is accustomed to the traffic of the busy street and is, therefore, able to identify the movements of each vehicle as he makes his way across the street, although to his country cousin all is confusion. Likewise, the student who understands football sees each individual play in the game, while to the novice a group of players merely moves back and forth across the gridiron. A new course of study is always more difficult at first, but after one has acquired a certain amount of information in the field and has made some progress with the method involved, the work seems to run more smoothly.

In general, we may consider heredity and training as the more permanent, or stable, factors in adjustment. The native equipment is constantly being modified by new experiences, but this change is relatively slight from day to day. If these were the only factors to be considered, we might expect to be able, knowing the past behavior of an individual, to predict how he will react under

any specific circumstances. The general trend of his behavior *is* predictable. Students are admitted to college on the basis of their past performance and are found to measure up in the main to the prediction that they are able to do work of college grade. That they do not necessarily conform in every respect to the prediction is in part due to their constantly changing habits. We are constantly making new habits and unconditioning old ones as our surroundings change.

(3) *Immediately preceding activity.* To predict what one will do or what he will observe at any particular moment necessitates not only knowledge of his habits, but also intimate knowledge of his immediately preceding activities. These constitute what frequently is termed his *attitude,* or general "set," of the moment.

The high-pressure salesman "develops" his intended victim by preliminary preparations—arguments that he knows his prospective customer will readily accept. The skillful advertiser investigates the "interests" of those who might use his commodity. If, for example, he finds that such people are already satisfied with a competitor's wares but are looking for opportunities to extend their business to foreign countries, he may head his advertisement, "How we compete in foreign markets." The fact that they are already "set" for foreign market discussions predisposes them to notice anything on this subject.

The influence of the more immediately preceding activity is illustrated by puzzle pictures. Doubtless the reader has observed a picture which at first appeared meaningless, or which contained some hidden element. When you are told what to look for, or when you have once discovered the meaning, the hiddent element stands out perfectly clear. Similarly, if one is asked to report

the number of $X$'s that he sees on a card which is exposed for a fraction of a second, and then after the exposure he is asked to report also the number of $O$'s, he will be able to report more $X$'s than $O$'s in spite of the fact that there are an equal number of each on the card.

The influence of previous activity is observable in the ease or difficulty with which we understand a lecture or a book that we are reading. If the lecturer or author is coherent in his statements, we have no difficulty in following him; but when he frequently shifts his point of view, we are left unadjusted by each shift and react more slowly to each succeeding statement. On the other hand, when the speaker hesitates, we are often able to finish his sentence. Also it is much easier to read words that make a sentence than it is to read disconnected words. Each word in the sentence is a preparation for the next.

(4) *Social factors*. We have previously stated that the stimuli of the external environment may be conveniently classified as physical and social. The behavior of others is a social stimulus, but it has a more far-reaching influence than the physical stimuli already discussed. In other words, so far as our behavior is concerned, our social environment is more complex, and hence more important for our consideration and more difficult to treat. What shall be effective in our social environment, however, is dependent upon our development—the habits we have already formed with reference to the group.

A striking example of this fact is shown in the attitude of a convict who was interviewed in a state penitentiary. He expressed great remorse for his previous behavior and declared that he was trying to be a model prisoner in order that he might get his sentence reduced as much as the law allowed so that he might go back and prove to the world that he was not "yellow." It developed that what

he meant was that he was in disgrace for having been caught and wanted to get out in order to rob another bank and prove to his fellows that he could get away with it.

Most of us have developed habits of adjustment to the standards of the larger social group. We conform to the customs of society as a matter of course. We refrain from crime or bad manners, we listen to the concert or go to the art gallery, because of our knowledge of the opinions of others and because we have developed the habit of conformity to their opinions.

**Control of others.** Another form of social stimulus is what is often called "suggestion." A frown from the instructor causes the drowsy student to sit up. "What is in this picture?" is a suggestion that there is something to be observed. A question is a social stimulus, but whether it will be an adequate stimulus in any case depends upon the habits of the person to whom it is put and upon his general attitude at the moment. Suggestions are often misleading in that we fail to observe outstanding features of the situation and even observe characteristics that are inadequately represented or entirely absent.

The author has presented to a class a large reproduction of the picture of the brain in Figure 35 and talked for fully 10 minutes about a fictitious cortical center of attention before any student noticed that the picture contained the outlines of several infants. The magician relies upon the factor of suggestion when he makes several passes, or he keeps up a steady flow of chatter to his spectators while he does the trick. While they are watching one thing, he is doing something else that otherwise could be easily observed.

How far one can succeed in the control of the behavior

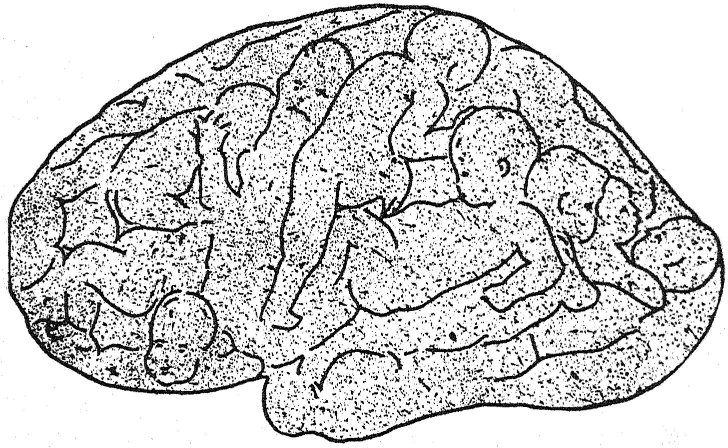

**Figure 35.—We see what we are expecting to see.** (*Titchener after Gudden.*)

of another individual through suggestion is dependent upon the skill with which the suggestions are presented and the character of the habits of the individual in question. The first social stimuli or suggestions should be such that they conform with the habits of the person to be influenced. In a religious revival, the meeting is opened with the singing of hymns and several brief speeches by the leaders. Then converts are called upon to tell their experiences. The former drunkard who has reformed and now declares that he "has money in his pocket and doesn't want a drink" is a more important factor in the response of the man who is "down and out" than any argument by one who has not been in his situation.

## Restriction of the Field of Activity

In sales talks, it has been found effective to begin with statements and observations which are matters of com-

mon agreement, so that the customer is forced to agree with the salesman. The salesman may then introduce statements which earlier would not have been acceptable. Having previously agreed, the prospective customer will now agree more readily than he would otherwise have done. Having made an adjustment which was relatively easy, he more readily adjusts to the following shifts in the situation.

Holding the "attention" of the customer is one of the salesman's hardest jobs. From an application of the foregoing discussion it will be easy to see that "holding the attention" means restricting the customer's field of *reaction* to a small group of pertinent stimuli. How completely this restriction comes about is a question of the finesse of the salesman.

In other situations it is the field of activity that becomes restricted. Thus, when we read an absorbing story, the details of the room, the chair, the light, the pressure of our clothes, and so forth, all fade out of the picture. All that is left is the page in front of us, and even our reactions to that are highly circumscribed. Thus, we do not react to the page number, to typographical errors, to sentence structure, or to grammar.

Under certain conditions, we might aid the process of restriction by arranging the situation so that the field of activity is greatly reduced. One way of doing this is to sit in a darkened room, which in one stroke cuts out a variety of visual stimuli. Another way is to concentrate, or to become active with reference to a single situation until most of the surrounding stimuli become ineffective. For instance, if one sits in a darkened room with a small spot of light at which he looks fixedly while listening to a program of radio music, he will find that as he listens intently, all noises and other elements in his environment

fade away. If this condition is continued long enough, the subject is said to be "hypnotized."

**Hypnosis.** "Hypnosis," then, is merely a name for a condition in which the subject is reacting to a highly restricted group of stimuli. He is really "attending," but attending more completely than is possible under ordinary conditions.

One unique condition prevailing during hypnosis has given rise to considerable hocus-pocus in the practice of hypnotic induction. This is the relationship which obtains between the "hypnotized" and the "hypnotizer," the latter being more frequently designated the "operator." It happens that when one is preoccupied under the conditions described above, he does not have the inhibitions produced by a variety of stimuli, and will, therefore, carry out the commands or suggestions of the operator more completely than he could, or would, if other extraneous stimuli were not present. This is not an unnatural condition but is the same sort of thing that occurs when a husband acts on suggestions given by his wife if no one else is present although he adopts a negative attitude in the presence of company.

**Hypnosis not magic.** This perfectly natural fact has given rise to the notion that some peculiar relation exists between the two persons involved in an hypnotic experiment. This condition is technically designated as *rapport.* Rapport, itself, is nothing strange, peculiar, or unique. Every effective public speaker—and every successful actor—must establish rapport between himself and his audience. The induction of hypnosis is very similar to the salesman's "development" of a client. The salesman also is attempting to establish rapport. The technique of "getting over" is a matter of a knowledge of

the specific conditions involved and need not be considered further at this point.

In the very early practice of hypnotism as practiced by Mesmer and his disciples, this rapport was considered to be an attraction called by them "animal magnetism," from its analogy to "metallic magnetism," which during Mesmer's activities in Paris was a popular plaything. In order for this animal magnetism to pass from one person to another, it was supposed to be necessary that they make actual physical contact. Later development of the technique by vaudeville performers has permitted passing of the hands before the eyes and a muttered gibberish with the same effect. Modern laboratory procedure frequently substitutes a victrola record for the personal operator.

Thus, we see that animal magnetism is in the same category as stellar influence over human destiny; but, as with other magical practices, some people still insist today that magical rites are highly efficacious, and wear belts containing magnets as a cure for rheumatism or an asafetida bag around the neck as a protection against colds. In other words, hypnosis as practiced publicly for entertainment is as different from the practice of hypnosis in the laboratory as alchemy is different from modern chemistry.

It is true that a commanding or prepossessing appearance is convenient in the practice of hypnotism, but in the same fashion that it is convenient in any other practice. It is also true that a beginner will have little success in hypnotizing his own friends or family, but what prophet is not without honor in his own country? Even a practicing physician rarely treats his own family and in some states is enjoined by law from doing so.

**Hypnotizer not important.** Another popular misconception with regard to hypnosis involves the assumption that the operator must be a "strong-willed" individual and that the subject must be relatively "weaker-willed." This assumption is entirely without foundation. As a matter of fact, if the subject is willing, practically any normal adult may be hypnotized by the procedure outlined above, or by various other techniques involving the same principles. Young children, animals, the feeble-minded, and so forth, cannot be hypnotized because they cannot attend to one thing long enough for their activities to become restricted.

Another misconception regards the appearance of supernatural powers on the part of hypnotized subjects. Upon the proper suggestion, the hypnotized subject will raise his arm above his head and hold it there much longer than the non-hypnotized subject is able to do, but this merely means that he is not attending to the sensations of fatigue which arise from this arm, just as we, in normal situations, may read an exciting story or attend a play without realizing that our foot has gone to sleep. The ability to discriminate in hypnosis and non-hypnosis has been investigated experimentally, and it has been found that the hypnotized subject can make no finer discriminations than any attentive, intelligent individual who works hard enough at the task.

The fact that it can be suggested to the hypnotized subject that he is not able to feel pain and that, consequently, he will not feel any led to an early development of the technique of hypnosis in major and minor operations. This development occurred largely in France and prior to the discovery of general anesthesia. The technique of general ether anesthesia is so much more con-

trollable than the technique of hypnosis that the latter has been almost superseded in modern surgical usage.

**An experiment in hypnotic suggestion.** Hypnotized subjects are supposed to carry out the suggestions given them during hypnosis more completely than non-hypnotized subjects are able to do. Kellogg[1] has experimented on this phase of the general problem. To a non-hypnotized group of subjects it was suggested in the ordinary fashion that they breathe twice as fast on the even-numbered pages of a book that they were reading as on the odd. To the experimental group the same suggestion was given during hypnosis. The subjects were tested at various intervals from 15 minutes to 90 days after the suggestion had been given. The tests were made by getting breathing records of the subjects.

Six of the 8 experimental subjects were never aware during the whole experiment that they were breathing faster on alternate pages. The control group (non-hypnotized), of course, knew that they were carrying out the directions, and as a result of this fact they became more proficient as time went on. On the other hand the experimental group, although showing a slight increase in efficiency due to continued practice, in general did not carry out the instructions as well as the control group. Even after 90 days, however, there was some difference in the breathing records between the alternate pages.

Therefore Kellogg concludes that there is a low order of obedience to hypnotic suggestion for an indefinite length of time. This experiment illustrates that it is possible to experiment with hypnosis in the same way that one can experiment with any other psychological

[1] Kellogg, E. R., "The Duration and Effects of Post-hypnotic Suggestion," *Jour. Exper. Psych.*, 1929, Vol. XII, pp. 502–514.

phenomenon, and that it is unnecessary and unwise to use spectacular procedures.

**Voluntary and involuntary attention.** It is usual to speak of those acts which seem to be due to choice as voluntary, while those that seem to be forced upon the individual by external circumstances are considered involuntary. Fundamentally, the two types are not distinguishable, though for convenience we may define voluntary attention as that in which the more personal factors of heredity and training predominate, and involuntary attention as that in which the dominant factors are represented by the external conditions.

Thus, someone interrupts me while I am writing. I "involuntarily" stop to listen to him. On the other hand, I continue to work when I would prefer to read a new journal that has just arrived in the mail. My present act is "voluntary." Yet the distinction is not so simple as these statements would imply. I might continue working and not notice the intruder; or, I may in a moment turn to the new journal, for it may contain an article that I have been expecting. Either act will be largely dependent upon habits or training, as well as upon the strength of the stimuli: if I am accustomed to the coming and going of other persons, or if the work is urgent, I may not notice new arrivals, and so on.

### Questions for Review

1. Try to observe your own behavior while you are studying and distinguish between the primary and secondary bodily adjustments.

2. If you habitually sit at the table to read your textbook, assume another position in an easy chair or lying down. Why does this interfere with your attention?

3. What is meant by attention as a total adjustment?

4. Three judges disagreed as to which of three contestants in a hundred-yard dash crossed the tape first. What is the psychological explanation of this disagreement?

5. If you have developed a high degree of attention in the study of zoölogy, what influence would this training have on your attention in the study of psychology?

6. A spectator mimics the facial contortions of the comedian on the stage. What is the psychological significance of this behavior?

7. Criticize the two statements: "We attend because we are interested" and "We are interested because we attend."

8. Why can some people be hypnotized more easily than others?

### References

Kellogg, Ewart R., "Duration of the Effects of Post-hypnotic Suggestion," in *Readings in Experimental Psychology,* New York, Harper and Brothers, 1931, edited by W. L. Valentine, pp. 298–309.

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## CHAPTER XVI

# Efficiency of Organization

**The range of attention.** A problem which often arises is that of how many objects may be perceived at one time. In general, the number will depend upon the simplicity of the objects and the extent to which they may be grouped into a unitary pattern. Thus, one may recognize the word "psychology" at a glance, but when the letters are pied, only five or six letters will be seen in a single brief exposure. In the one case it is the word that is seen, while in the other it is the disconnected letters. More dots in irregular position will be reported than disconnected letters. Again, if the dots are arranged in rows or in some definite pattern, a still larger number can be correctly reported.

The usual method of investigation employs a tachistoscope, or exposure apparatus, which permits of the control of the time of exposure, which should be sufficiently brief to avoid the possibility of eye movements, counting during the exposure, or a lasting afterimage, and at the same time should ensure proper fixation of the eyes for clear vision.

In the apparatus illustrated in Figure 36, the card containing the material is placed in the holder at one end. The subject rests his head against the hood at the other end. When the subject is in this position and the shutter is closed, there is not sufficient light admitted into the box to illuminate the card. A pinhole in the center of the

card ensures fixation in the proper direction and at the correct distance. The shutter can be adjusted to admit the light for any short period required. Under such conditions it has been found that an exposure time of 1/10 of a second is sufficient for clear vision and at the same

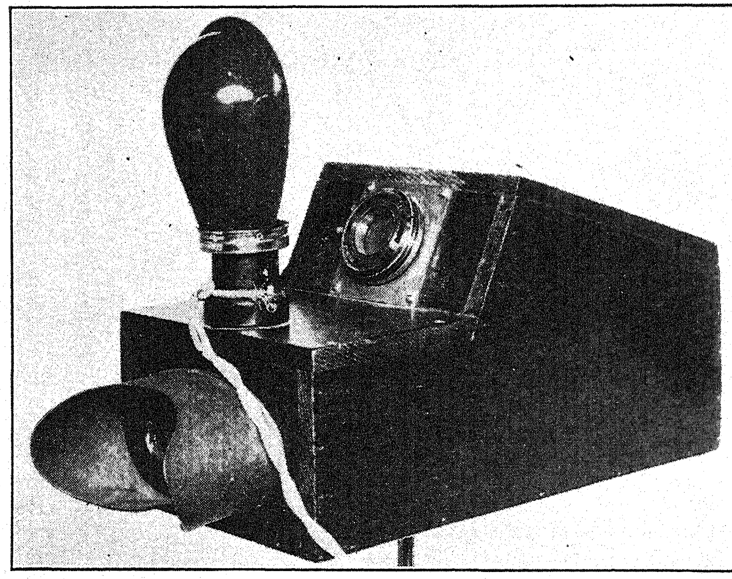

**Figure 36.—One type of tachistoscope.** The subject sits with his head against the headrest and fixates a pinhole in the card inserted at the opposite end. The experimenter operates the camera shutter, which may be set for an exposure of from 1/100 second to ½ second. When the shutter is open, light from the lamp illuminates the material printed on the card. (*C. H. Stoelting Company.*)

time does not allow time enough for a change of fixation.

The comments of the subjects investigated indicate that material irregularly spaced is in most cases grouped into some sort of pattern, and occasionally into two or more smaller patterns. If the arrangement is such that grouping is easy, 12 or 15 or even more dots may be cor-

rectly reported. Where patterns are difficult, the limit is reduced proportionately to 5 or 6 dots. With letters and other symbols, particularly if the individual symbols are to be reported, the limit is still further reduced.

In one experiment, in which dots, letters, and geometric forms were used, the subjects worked under four types of instruction.[1] They were asked:

1. To give the *number* of dots.
2. To *name* the letters.
3. To *name* the geometric forms in one series.
4. To *describe* the geometric forms in another series.

The cards containing the stimulus objects were exposed for .078 of a second each in a tachistoscope. There were, in all, 100 presentations at each level. That is, where the number of dots on the cards varied from 3 to 15, there were 13 cards which were presented 10 times each in haphazard order. Each series was run 10 times, making 1300 exposures for each subject.

Under these conditions it was found that the threshold, or limen (the point at which the number was reported correctly in 50 per cent of the cases), was 11.3 dots for one subject, 6.2 dots for another, and 9.2 dots for a third subject. On the other hand, when the same three subjects were required to name letters, the thresholds fell to 7.9, 6.9, and 5.9 letters. When the geometric forms were named, the thresholds were 4.3, 3.2, and 3.9 forms for the respective subjects. Finally, when they were required to describe similar forms, the thresholds were 3.3, 3.0, and 3.3 forms. In other words, the more complex the task required, the fewer were the discrete elements that could be observed during the period of exposure.

[1] Glanville, A. Douglas, and Dallenbach, K. M., "The Range of Attention," *Amer. Jour. Psych.*, 1929, Vol. XLI, pp. 207–236.

**Successive stimuli.** If the stimuli are presented successively, as the rapid clicks of a telegraph sounder would be, the results are somewhat the same as with simultaneously presented material. In a slow presentation, the subjects count the clicks, but if the clicks are presented too rapidly for counting, a grouping of the clicks is relied upon, even though the clicks themselves are evenly spaced. With a little practice, the subject can count by two's or three's without attempting to count the individual clicks in each group. With further practice, the size of the groups may be still further extended.

If the clicks are presented in groups, or in some rhythm, the subject soon acquires the ability to report large numbers of clicks. The possibility of increasing the span by grouping is illustrated in the learning of the telegraph code. At first, the learner must count the clicks for each letter; then he recognizes the pattern of clicks representing each letter as a letter without counting; and finally word patterns, and even phrase patterns, are acquired.[2]

**Organization of tasks.** In the complex performance, the task is difficult until one becomes sufficiently skillful so that the whole may be represented as one act. When one is learning to drive an automobile, the clutch, brake, gas, and wheel each requires special adjustment on the part of the driver. Later, he is able to adjust himself properly to the whole as a single unit.

The degree of adjustment to one stimulus, as compared with several stimuli, is illustrated in an experiment in which the subject was required to react by pressing a key in response to one of four telegraph sounders. In the first experiment, the sounds were presented in irregular order and the subject was to press his key every time he

[2] Bryan, W. L., and Harter, N., "Studies in Telegraphic Language," *Psych. Rev.*, 1899, Vol. VI, pp. 345–357.

heard the one previously designated. It was found that when the subject had had a little training, the difference between the sounds could be greatly reduced, and that the subject still made a high percentage of correct reactions.

One marked characteristic of the results was that the three sounds to which the subject was not to respond were seldom distinguished from each other during the experiment. If one of these three was given alone with the one to be discriminated, as 1 2 2 1 2 2 2 1 instead of 1 3 2 1 2 4 3 1, the subject would generally fail to report any change in the arrangement. He recognized the cue to which he was to react but failed to distinguish among the other three. When, however, he was required to react to each sound by pressing a corresponding key, the differences among the four sounds had to be greatly increased in order to permit the same degree of accuracy.

**Duration of attention.** How long one can maintain the attentive adjustment leads to a number of interesting problems. If he is reading a book, he may continue with little variation in the adjustment for several hours. If the reading is difficult, however, the period may be much shorter. Students generally report that in their study of difficult subjects 15 to 30 minutes of constant application are the limit before distractions interfere.

Under experimental conditions in which the object of attention is a single dot or some simple element in a picture, attention seems to fluctuate even more rapidly, persisting in each case only a few seconds. The duration of attention seems to depend upon the degree of adjustment required and the factors influencing the adjustment.

The course of a prolonged high degree of adjustment has been demonstrated in the reaction-time experiment in which the interval between the ready signal and the

stimulus to which the subject is to react is varied.[3] It may be supposed that, other things being equal, the more perfect the adjustment with regard to reacting to a specific stimulus, the shorter will be the reaction time. It was found that a 2-second preparatory interval was most favorable to the shortest reaction times, with a rapid increase in the reaction time as the interval was lengthened to 8 seconds or more. How long one can attend must depend upon the degree of adjustment that we set as our required standard. It would appear that under the conditions of this experiment the highest degree of adjustment is limited to the first 4 seconds and rapidly decreases thereafter (Figure 37).

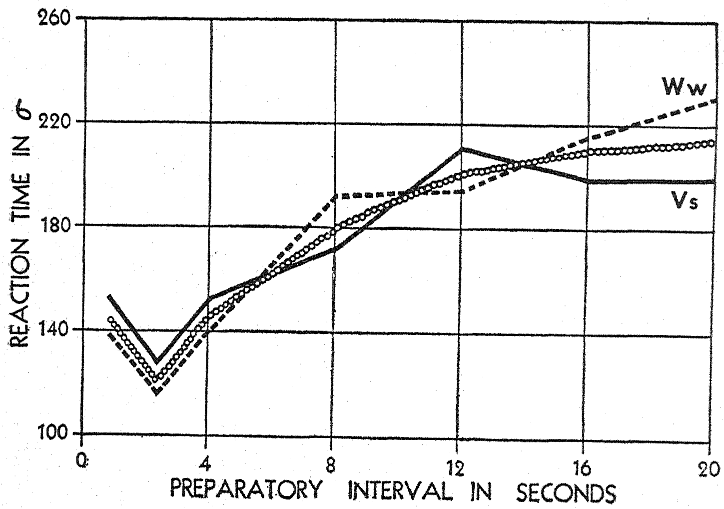


**Figure 37.—The variation in the increase in reaction time with increase in the duration of the preparatory interval.** The broken-line curve and the heavy-line curve represent the results experimentally obtained with subjects *Ww* and *Vs*. The circle curve represents the average for the two subjects. The abscissae represent the duration of the preparatory interval, while the ordinates represent the reaction times. (*Woodrow, p. 87.*)

[3] Woodrow, H., "The Measurement of Attention," *Psych. Mono.*, 1914, Vol. XVII.

**Fluctuation of attention.** Most experiments have made use of a liminal stimulus, such as a faint light or a weak sound, which can be perceived only under a high degree of adjustment. Under these conditions the stimulus appears and disappears, varying considerably in duration, but usually approximating from 5 to 7 seconds. The explanation of these fluctuations has been sought in:

1. The fatigue of the receptor.
2. The fatigue of the muscles of accommodation in the receptors.
3. The general bodily rhythms.

(1) *Fatigue of receptors.* The theory of fatigue of the receptors and their muscles of accommodation meets with important difficulties in the fact that the auditory mechanism fails to show a serious adaptation to stimuli, as is shown in the case of vision, and there is no evidence that the muscles of the middle ear, the tensor tympani and the stapedius, play an important part in accommodation to weak stimuli. Furthermore, it cannot be explained how the receptor recovers, if once fatigued, when the stimulus persists. More intense stimuli should also cause fluctuations, on this hypothesis, though actually the phenomenon is limited to a narrow range of intensities near the threshold of sensitivity.

(2) *Fatigue of accommodation mechanisms.* It has been suggested that eye movements, in the case of a weak visual stimulus, are the cause of the fluctuations. It is assumed that the muscles involved in fixation become fatigued and the fixation breaks down. The temporary relaxation which then occurs permits recovery and a refixation with a consequent return of perception of the light. This is the statement of a hypothesis.

How can we proceed to investigate whether this hypothesis is valid?

One investigator has taken advantage of his knowledge of the position and size of the blind spot in the retina. The subject was required to fixate a point of light exposed to one eye. A spot of light was then placed at the proper position so that it was completely covered by the blind spot. Any movement of the eye would expose this area of light and the subject could report that he saw it. The liminal light was exposed to a third area of the same retina and the subject was instructed to press a key while he saw this latter stimulus and to release it when the light disappeared. Under these conditions the subject is expected to attend to the three stimuli as one pattern. He must try to maintain his fixation on the point and report verbally every appearance of the light covered by the blind spot and by means of the key report the appearance and disappearance of the weak light.

The results show that there is some correlation between eye movements and fluctuations, though the fluctuations often occur when no eye movement is reported. On the basis of this experiment, we may conclude that eye movements are one factor influencing the fluctuations, but that there must be other variables in the posture, also, which have not yet been identified.

(3) *General bodily rhythms.* There is some evidence of other bodily rhythms which may be related to the fluctuations in the perception of a stimulus. For example, if the subject gripped a dynamograph with one hand, it was found that the stimulus disappeared and reappeared with the rhythmic decrease and increase in pressure exerted.

A further fact of significance is the dependence of the fluctuations upon the intensity of the stimulus. Guilford[4] has shown that if the stimulus is very weak, the period of invisibility will be long and the period of visibility short. As the intensity is increased, the period of invisibility will be progressively shorter and the period of visibility correspondingly longer until an intensity is reached at which visibility is practically continuous. At an intermediate point, the fluctuations will be most rapid and of equal length. This intermediate point corresponds to the limen of intensity, or threshold of sensitivity—that is, the stimulus is of such intensity that it will be perceived half the time.

**Total adjustment emphasized.** Evidently, if we consider attention as the total adjustment with reference to the stimulus and in the light of the facts presented, no single factor can be responsible to account for its existence or its fluctuations. It is more satisfactory to postulate that, at any given moment, there is in the organism a set of factors which are unfavorable to perceptibility, such as bodily rhythms, sensory and cortical fatigue, and shifting of various conditions of attention, such as external and internal stimuli. The stimulus that is perceived at any moment is, on the whole, favored by the disposition of these factors. At the limen, these factors are so balanced that there is an equal chance of perceptibility, and a more rapid fluctuation is due to the fact that this balance is easily overcome by a single factor or small group of factors. Continuous attention over a long period is possible when the task is easy; that is, under this condition the combination of

[4] Guilford, J. P., "Fluctuations of Attention with Weak Visual Stimuli," *Amer. Jour. Psych.*, 1927, Vol. XXXVIII, pp. 534–583.

factors is predominantly favorable. On the other hand, the difficult task is accompanied by numerous distractions because the factors are less favorable.

This argument is illustrated by the accompanying diagram (Figure 38). Let us suppose that the group of darts at $A$ represents the various factors at a moment of

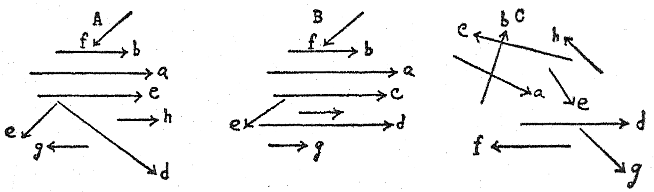

**Figure 38.—A Representation of the Various Factors in the Organism Which Determine the Activity of Attention and Emotion.**

total adjustment, when they are satisfactory for observing a stimulus of moderate intensity. The length of the darts may represent the importance or strength of the factors. In $A$, therefore, the factors $a$, $b$, and $c$ are relatively important and point in the same direction, while $d$ and several less important factors are either divergent or wholly opposed. In situation $B$, there is greater accord among the factors because factors $d$ and $g$ have shifted. We would expect, therefore, greater attention, as more factors are contributing to the adjustment. Hence, in the minimal light experiment, a light of lower intensity could be seen at moment $B$ than would be the case at moment $A$. As the organism is unstable, we would expect a "fluctuation of attention" with a very weak stimulus. In $C$, all the factors are divergent. This figure represents a more or less complete breakdown or disorganization.

This condition also suggests that what we know as "attention" is not an independent process at all, but

merely a name for a group of factors—stimuli, reactions, habits, and physical conditions of the organism. Only a few of these are known or can at any time be identified. If we could identify all the individual factors, the word *attention* would be useful only as representing the group.

### Effort and Attention

We frequently say that we attend because we try, or that we attend with great effort. This is in a sense true, but when we come to analyze the processes that we call "effort," we find that they resolve themselves into muscular tension. Muscular tension is an indication of organization of our reactions with reference to a situation among conflicting tendencies or conditions.

Attention to a difficult problem involves effort because we do not know its solution or fail to see its significance. At the same time, there are conditions of social demands that make the solution necessary, and habits of adjustment to similar situations make it possible, or even mandatory, that we continue in the presence of other disturbances. For another individual, no effort may be involved because the moment the problem becomes difficult—that is, opposition is met with—his adjustment shifts to something else. He has no adequate habits relevant to the present situation.

**Experimental studies of effort.** The conditions of effort are particularly evident in experiments in distraction of attention. If the subject is required to add columns of figures at his greatest speed and accuracy, or to make a specific reaction to each of several stimuli that are presented in rapid succession, it might be expected that any extraneous stimuli would interfere with his success.

In most cases, the reverse is true. A noise or a weak electric shock is generally accompanied by an increase in his performance, though presumably the subject had been doing his best under the normal conditions. The distracting stimulus merely becomes another factor in the conditioning of attention, and more energy can be expended than normally.

One investigator[5] devised an experiment which illustrates how the "distracting stimulus" serves as a stimulus to greater activity, which may include a certain amount of additional expenditure of energy in the task to be performed. A series of ten numbers or letters was exposed in chance order as fast as the subject could react to them by pressing a corresponding key. As soon as a key was pressed, the next number or letter was automatically exposed. Under the keys was arranged a device which recorded the amount of pressure exerted on each key.

During the course of the experiment, various distracting stimuli, such as the noise of a buzzer, a bell, and different types of phonograph records, were introduced. The results show that the efficiency of the subjects was often greater during the distraction. This increase in efficiency was accompanied, however, by greater pressure on the keys. In other words, the subjects worked harder as a result of the distracting stimulus, which became associated with the task and thereby failed to be a distraction.

**Simple versus complex tasks.** In another experiment[6] it was found that this facilitating effect of "distractors" was particularly pronounced when the task

[5] Morgan, J. J. B., "Overcoming Distraction and Other Resistances," *Arch. Psych.*, 1916, No. 35.

[6] Dockeray, F. C., "Attention, Distraction, and Fatigue," *Jour. Comp. Psych.*, 1922, Vol. II, pp. 331–370.

set was relatively simple; but when the situation was complicated and added incentives were supplied for efficient performance, the introduction of a distraction had only a minor effect as an added incentive. In the simpler task, the subject was to press a key every time he heard a certain previously selected telegraph sounder which was presented in irregular sequence with three others similarly tuned. The subject had no knowledge of his success, but was instructed to do his best. In this case, any distraction, even a relatively severe electric shock, was almost invariably accompanied by an improved performance.

In the second task, the subject was required to react differentially to each of three lights of nearly equal brightness and to two closely tuned sounders. The reaction consisted in the delicately controlled movement of touching with a stylus a plate beneath a small hole, corresponding to the specific stimulus, without touching the sides of the hole. This had to be done within a definitely prescribed time limit. If the subject touched the correct plate within this time limit, a lamp lighted, informing him of his success. If he touched the sides of the hole, another signal warned him of his error.

Thus, it can be seen that the subject had more to do, and had several added factors as stimuli, or incentive, to keep his efficiency at the highest point. Under these conditions a distraction, such as an electric shock, fatigue tensions, and so forth, was more frequently accompanied by a lowering of the performance record, or by only a slight improvement.

**Distractors and incentives.** On the basis of the results of these experiments, we may conclude that what we call "effort" is the activity aroused in the subject as a result of the conflict of motives and the utilization of

stimuli and previous habits in meeting the difficult situation. If he has assumed the set or attitude that the work must be done, the "distractors" are reminders that he may fail in the performance. They may then become effective stimuli or incentives. They goad the performer on to greater activity if the task to be performed is simple. If the task is already complex, demanding all the skill the performer possesses, the "distractor" is merely an additional complication.

Whether a stimulus will be a distractor or an incentive also depends upon the training of the individual. To some, a difficult task is a challenge. Others are accustomed to working in an easy, routine manner, and when the task is made difficult, as by the introduction of a stimulus extraneous to the immediate situation, they quit. These individual differences were clearly brought out in some of the experiments.

**Fatigue.** When you have been working continuously adding or multiplying or studying assignments, you realize that you are becoming tired or fatigued. You begin making mistakes; you read more slowly; "your mind wanders." Sometimes you merely have a "feeling of being tired" without being able to identify just what this feeling is. Then you question whether it would be better to go on with the work or to rest. You argue that if you work, you will make more errors or work more slowly, and that, therefore, you can save time by resting.

Experimental investigations of continuous "mental work" have produced interesting results. When one is instructed to add columns of figures as rapidly and accurately as possible for several hours, he will show little change in either speed or accuracy, but he will declare that he is greatly fatigued, that he could scarcely keep

going, and so forth. In one experiment[7] the subjects were required to work continuously for five hours. At regular intervals, they rated their feelings of fatigue. The results are plotted in Figure 39. It will be seen

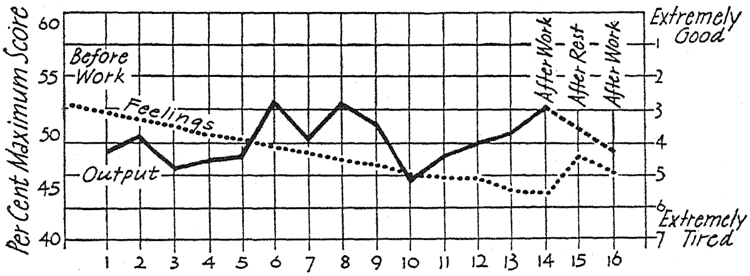


**Figure 39.—Curves of the Feelings of Fatigue (Dotted Line) and of Actual Output.** (*Poffenberger.*)

that their feelings of fatigue were estimated as constantly increasing, though the actual output of work accomplished varied throughout the period but was as great at the end as at the beginning.

If numbers are dictated to the subject at a rate near his maximum speed of adding, and he is told that the experimenter will later decide when to stop, the results of the test will be quite different from that in which the subject determines his own highest speed. After an hour and a half of adding from dictation, his accuracy will be only about sixty per cent of what it was at the beginning of the period. The fact that he must keep up with a set standard or fail is a more difficult task than shifting his own standard between speed and accuracy.

**Diurnal variations.** Efficiency seems to vary at different hours through the day, though here again it does not conform to what might be expected or to the reports

[7] Poffenberger, A. T., *Applied Psychology*, New York, D. Appleton and Company, 1927.

of feelings of fitness as expressed by the subject. If one is active throughout the day, one might expect that his efficiency would steadily diminish. Table V indicates the variations in the efficiency of school children in several tasks. The efficiency from nine to ten o'clock is taken as the standard. It will be seen that on the whole, children accomplish slightly more work each hour up to noon. The greatest drop comes at one o'clock, but they are nearly back to the maximum efficiency at three o'clock. It may be that the approach of the closing time is an incentive to increased effort, and that at eight o'clock and one o'clock they are not yet thoroughly down to work.

TABLE V

VARIATION IN EFFICIENCY DURING THE DAY.[8] THE ACHIEVEMENTS AT THE SEVERAL HOURS ARE PROPORTIONAL TO THAT AT THE 9-10 A.M. HOUR, WHICH IS 100.0 IN EACH CASE. AVERAGE RESULTS FOR 240 PUPILS FROM GRADES 5 AND 6.

| *Performance Tested* | *9-10 A.M.* | *10-11 A.M.* | *11-12 M.* | *12-1 P.M.* | *1-2 P.M.* | *2-3 P.M.* |
|---|---|---|---|---|---|---|
| Addition | 100.0 | 102.4 | 104.2 | ....... | 102.3 | 103.0 |
| Multiplication | 100.0 | 101.9 | 105.1 | ....... | 100.9 | 103.0 |
| Memory for Auditory Digits | 100.0 | 105.9 | 106.7 | ....... | 99.4 | 102.4 |
| Memory for Visual Digits | 100.0 | 103.2 | 109.2 | ....... | 99.1 | 103.4 |
| Recognition of Nonsense Syllables | 100.0 | 104.7 | 105.3 | ....... | 100.0 | 103.7 |
| Completion | 100.0 | 105.0 | 109.7 | ....... | 106.2 | 108.8 |
| Average | 100.0 | 103.8 | 106.7 | ....... | 101.3 | 104.1 |

Using the technique described on page 239, one subject was tested for several days. He was a very persistent

[8] Gates, A. I., *Psychology for Students of Education*, New York, the Macmillan Company, 1923, p. 384.

worker on a regular schedule every day. He believed that he was a morning worker and did his best work immediately after breakfast, "while he was fresh." It will be seen (Table VI) that his variations in efficiency somewhat parallel those of the school children.

TABLE VI

ONE SUBJECT'S EFFICIENCY VARIATIONS DURING THE DAY. THE SCORE AT 8:00 O'CLOCK IS TAKEN AS THE STANDARD. IN CASE NO TEST WAS GIVEN AT 8:00, THE PER CENT IS BASED ON THE MEAN OF THE TWO NEAREST DAYS.

| *Day* | *8 A.M.* | *11 A.M.* | *1 P.M.* | *4:30 P.M.* | *9 P.M.* |
|---|---|---|---|---|---|
| 1 | 100 | 111 | 94 | 137 | |
| 2 | 100 | | | 107 | |
| 3 | 100 | | | 81 | |
| 4 | | | | 69 | |
| 5 | 100 | | | 173 | |
| 6 | | 166 | | 125 | |
| 7 | | 139 | 77 | | |
| 8 | 100 | 133 | 70 | 122 | 109 |
| 9 | | 120 | 75 | 138 | 134 |
| 10 | 100 | | | | |
| 11 | 100 | | 114 | 114 | 94 |
| 12 | 100 | 95 | 102 | 99 | 101 |
| 13 | 100 | 105 | 78 | 108 | |
| 14 | 100 | 111 | 80 | 113 | |
| 15 | 100 | 107 | 61 | 95 | 75 |
| 16 | 100 | | 91 | 53 | |
| Total | 100 | 121 | 83 | 113 | 103 |

**Fatigue and interest.** From these samples of experiments on fatigue, we may conclude that what we call "fatigue" is not an inability to work because of a loss of energy, but a loss of interest or failure in organization for the task in hand. Monotonous work and work to which we have not yet warmed up are difficult because of our lack of sufficient adjustment. We could do more work if we were sufficiently interested. Distracting in-

fluences, such as aching muscles, help to destroy the specific posture. In the test situations, we are often spurred on by the knowledge that we are being tested, whereas if we were merely doing our own work, we would give up. When we get interested in our work, we are sometimes surprised to find how long we can continue without feeling fatigued.

### Questions for Review

1. What factors are involved in determining the number of objects that may be perceived at one time?

2. How would you go about collecting experimental data to determine whether the colors, size, and shape of figures and letters, and so forth, now used are the best for automobile license plates?

3. Give some examples of situations in which a smoother performance occurs when the task is performed as an organized whole rather than in parts. Could this difference distinguish the virtuoso from the "dub" in complex skills?

4. In view of the discussion regarding the duration of attention, what interpretation must be placed on claims by some individuals that they can "concentrate" for an hour or two hours at a time?

5. How can the curves in Figure 37 be used in connection with the reaction time experiment described in Chapter III?

6. What are the physiological reasons for the duration of attention?

7. Apply some specific situations to the diagrams in Figure 38.

8. What generalizations can be made concerning the effect of distractors?

9. Why are some tasks in which a great deal of muscular activity is involved not accompanied by the feeling of effort characteristic of tasks requiring less activity?

10. Contrast the psychological and physiological concepts of fatigue.

11. What are the important factors that determine diurnal variations in efficiency?

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# SECTION VI. DISORGANIZED RESPONSE



References to Student's Guide:

Exercise 47. Changes in Blood Pressure under Different Types of Stimulation
Exercise 48. Circulatory and Respiratory Changes
Exercise 49. Motor Control
Exercise 50. The Detection of Hidden Knowledge
Exercise 51. Anger Diary
Exercise 52. The Judgment of Emotion from Photographs of Facial Expression
Exercise 53. Emotional Immaturity

## CHAPTER XVII

# Disorganized Response—Emotion

In the preceding chapter, we have described a development of adjustments to everyday life. Through experiences with objects, persons, and many other complicated situations, the individual builds up many response patterns, so that he is able to adjust or react with readiness to the changing conditions in his environment in a generally organized manner. There are times, however, when there arises a situation in which we have no ready response either because the situation is new in many important respects or because we have failed to learn how to behave in that particular type of situation.

The student who has lived in a home where he has been protected all his life finds, when he reaches college, many new situations for which he has no training that will be effective. Possibly a professor seems austere or sarcastic, and the student experiences either fear or anger. Later, he learns how to deal with this professor, and he takes the professor's harsh words as a matter of course. We say that he has become adjusted to this situation. Before he becomes adjusted, his actions are rather diffused or disorganized.

It may be that certain situations are always distracting to us. In other words, we always experience a certain amount of disorganization. Thus, while I am writing, someone is playing the piano in the next room. The music interferes with my work. My motive is to write

this chapter within a given time. I am in the habit of writing and I have a fairly good notion of what I wish to do, but I have never been able to concentrate successfully on one task in the presence of music, good or bad. I find myself following the harmonies, or tapping the rhythm. In the present instance, in which there is a conflict between the two lines of activity, I find that I lose my train of thought; a sentence is disarranged; I strike the wrong keys; and I frequently find that I am trying to write in the same rhythm as the music.

Again, a man is returning home after several weeks' absence; he walks through the station with the expectation of meeting members of his family. He is animated; his walking is vigorous; his breathing is tense. We say that he is excited, thrilled, or expectant. In both of these instances there is fairly satisfactory adjustment; each of us performs his task, the one to write and the other to walk through the station. But in each case there is a certain amount of diffused activity; in each there is a partial maladjustment. To this diffused or disorganized behavior we usually apply the term *emotion*.

**Identity of emotions.** It should be understood that human behavior had been observed and categorically described long before any scientific description of behavior was possible. One of these categories, emotion, developed into a very complex system of fine distinctions which it has been considered the province of the literary man to describe and of the actor to portray. A list of the emotions which these people have delineated would include love, hate, anger, scorn, joy, fear, sorrow, grief, consternation, wonder, sacrifice, astonishment, and admiration.

At first glance, it appears as though these are as dissimilar as any types of behavior could be. A critical

examination, however, will show that in each one of these cases, even love or hate, there is a similarity in the *maladjustment* of the individual experiencing the emotion. The man in love is not an efficient man; the man who becomes angry and loses his head is likely to lose more than his head.

It therefore becomes the task of the psychologist to point out the elements common to the various situations with reference to the behavior of an individual who is said to be experiencing an emotion. While we yet have much to learn, we are now convinced that the similarity of these various situations lies in the lack of adjustment or organization in the behavior category known as emotion. Thus, we would say that there are not many kinds of emotion, but only one kind, and that the other non-emotional characteristics make it convenient to use, among others, the terms listed above.

**Disorganization in a situation of danger.** The nature of a disorganized response may be better understood if we take an example in which the reactions are violent and the disorganization more pronounced. Let us take an incident that occurred to a young man while walking along a quiet, shaded street at a late hour at night. He seemed to be rather oblivious of his surroundings. Possibly he was thinking of the early evening's entertainment.

Suddenly a loud noise seemed to issue from the darkness in the gutter close beside him. His muscles instantly became tense, as though he were going to leap, but he turned in the act of investigating this strange sound. The second time the sound occurred, he realized that it was a human voice. He attempted an inquiry, but his chest was too high, owing to the sudden intake of breath, and he had no control of his voice. In a short

time he became partially adjusted to the situation and was able to inquire what the man wanted, though his legs were trembling and he still had a lump in his throat. Incidentally, he found that the man was drunk.

The constituents of the situation in this case are:

1. The sudden presentation of a situation for which the man was not prepared. Had he merely met a policeman, or had a fire engine clattered by, or had it been in the daytime, when he was accustomed to many people and many noises on the street, the situation would have been quite different.

2. He had no ready response and was not able immediately to adjust to the situation. If similar situations were of frequent occurrence and he had acquired the habit of reacting in a definite way, he might have thus acted on this occasion.

3. There was a conflict between two opposing responses: (a) fleeing from danger, that is, a conditioned withdrawal response from loud noises as from something indicating painful or harmful stimuli; (b) investigation, which in this case we may presume is the result of habits formed with reference to his nightly duties as a night police reporter.

**A demonstration of disorganization.** The following experiment, which the author once performed with a group of students, serves to emphasize certain other characteristics that are frequently displayed in situations for which the individual possesses at the moment no ready response and in which the adjustment of the subject breaks down with reference to the specific situation, his responses are diffused, and he consequently misinterprets the specific events before him.

The following details of the experiment are important. The students were called from the laboratory into the

lecture room. Here there were a hundred ordinary classroom chairs arranged in ten rows with a narrow aisle on either side. In the front of the room was a platform extending the full width of the room. On this was a long demonstration desk. At one side of the room were two doors leading into the hall, and at the opposite side of the room were the windows, five feet from the floor. The window at the end of the platform was open. The students were scattered in the first five rows. The lecture was purposely dull, consisting of a review of instructions for laboratory procedure. It had been prearranged that in about fifteen minutes the janitor was to come in to sweep. He and the instructor were to have an argument; the janitor was to draw a gun; a man outside the open window was to fire a gun; and two students, *A* and *B,* were to come to the instructor's rescue.

After the lecture had proceeded for some time and the students were settled into their accustomed attitude, the janitor came in and sprinkled sweeping powder across the front of the room. The instructor told him, "You can't do that now," but the janitor gruffly replied, "I gotta sweep. You ain't got no business in here this hour." Then he went out. The students seemed to enjoy the parley between the janitor and instructor.

With a great deal of embarrassment the lecture was finally under way again, when the janitor returned with his broom. This time the instructor came down from behind the desk and attempted to interfere with the janitor, who pushed at him vigorously with the broom. The instructor attempted to grapple with the janitor, but the latter stepped back and drew his revolver. At the same time the man outside fired his revolver near the open window. The students, *A* and *B,* rushed to the

rescue, but student *C*, misjudging the situation, got there first, with the result that *A* and *B* went to the aid of the janitor.

The class was already in great commotion. Some of the students rushed for the door; chairs were piled up so that some could not have reached the doors if they had tried; one girl was clutching her throat as she gazed with wide open eyes and mouth upon the scene before her. An observer in the back of the room was able to head off the rush, though one man got outside of the building. *A* and *B* finally managed to pull *C* off the janitor.

When the students were again assembled, they were asked to write exactly what had taken place. They realized by this time, of course, that the whole affair had been a hoax. In every case they gave a surprisingly accurate account of the lecture and every event up to the point at which the janitor had displayed the revolver. One report ended cryptically at this point with the statement, "Then I left." Some stated that the instructor drew the gun. One said both the janitor and the instructor had guns, but he could not tell which fired the shot. One said he could not tell who fired the shot, but that he saw smoke. (This was possible, but the smoke must have been ten feet from the fight.) Student *C* was certain that the janitor had fired, for he "had hold of the gun when it went off." The girl who was observed surrounded by chairs, unable to escape, and looking directly at the scene as the janitor and student scuffled, reported no more accurately than the others.

**Organized and disorganized behavior.** The chief characteristic displayed by these students was that they acquired a confusion sufficiently great to prevent an accurate report of the events. This confusion we have

previously referred to as a diffused response. It is typified by lack of organization; that is, it is the opposite of what we describe as attentive behavior (Chapter XV). When we are attending, we are adjusted to the situation. Our total response is organized. In this situation the attentive behavior was disrupted or disorganized. Between these two extremes of organized and unorganized response, there are all gradations.

I may be writing; everything is working smoothly; I have the paragraph clearly outlined; my fingers play over the keys, not rapidly, but at least with ease; my whole posture is organized for this particular activity. Then my neighbor begins playing the piano again; I am slightly distracted; perhaps I hit the wrong key, or I lose the plan of my sentence. Though I continue my work, I am slightly disorganized. I may say that I am irritated or confused or distracted by the outside interference. Again, I may be elated over the progress I am making; I am developing a statement with which I am greatly pleased; my enthusiasm may become so great that I can scarcely wait until I have finished writing it. Here again we have a diffused response, though we do not recognize it so readily as belonging in the same category as the former. Either may reach the stage where there is complete disorganization.

It may be argued that those students who ran from the room certainly displayed organized activity. This may be quite true. Only to the extent that their running was frantic, haphazard, or in other ways something besides mere running was their behavior disorganized. A person may be crossing the street and find it wise to step quickly or run, in order to avoid being hit by an automobile, without the arousal of anything he would call an emotion. He merely displays a satisfactory, organized response.

At another time, he may be angry at the driver for his carelessness, or frightened because the escape was considered close. His anger or fright is something more than the behavior described as "running."

**Instinct and habit in emotion.** The fleeing from danger is frequently explained on the basis of instinct. We have already pointed out that the concept of instinct cannot be satisfactorily employed as a description of human behavior. In the case of flight from danger, the response has been developed by previous experiences with similar situations in which pain was the consequence. In the young infant, withdrawing from or rejecting painful stimuli is at first the result of random responses and is soon learned as a specific response. In the adult, this type of response has developed into more complicated habits: he still jerks the hand or foot away from a painful stimulus, but he has learned to escape more complicated dangers by more devious reactions.

A more important aspect of the situation, and one which frequently has led to the instinct assumption, is that in what we call "emotion" the behavior is on a lower level of performance so far as the total behavior pattern is concerned. With the disorganization, the individual resorts to the more primitive types of reaction—not merely those that are instinctive, but the more firmly established habits. He may undergo definite changes in the respiratory and circulatory functions, as well as changes in the secretions of the glands; the skeletal muscles may be under greater tension, or more relaxed. These are purely physiological changes in adjustment. He also on occasion bares his teeth, snarls, and utters sounds like an ugly beast; he clenches his fist and strikes, or bites, his antagonist. On other occasions he weeps, humbles himself before the other person; he may flee, lie,

steal, or beg. Later, he is chagrined at the recollection of his behavior.

These are extremes of behavior which we do not expect from the better class of people, even under the more extenuating circumstances. Nevertheless, the professor reprimands the student who has irritated him, and regrets his own behavior in his quieter moments. It is not a question of whether this behavior is instinctive. We can easily see that it is more elementary or primitive than the behavior the individual displays when properly organized or adjusted. By "better class of people" we refer to that group, regardless of their social or educational status, who are able to maintain a satisfactory total adjustment. Each individual under the conditions of emotion fails to maintain this superior organization. His behavior then is of those types that resemble the child's, or the inferior individual's, or even that of animals of a lower order.

**The autonomic nervous system in maladjustment situations.** We have frequently alluded to some of the internal changes that take place during disorganization, as well as the vigorous response of the skeletal muscles. It is common knowledge that one sweats when angry or excited. The heart beats faster and respiration is increased or, if breathing is inhibited, there is a tenseness about the chest. The face becomes flushed or blanched, and tears may be in evidence. It is also noted that one frequently loses his appetite not only when he is worried or angry, but also when he is overjoyed or excited. As these responses result through the action of the autonomic nervous system, they suggest that this part of the individual must play an important rôle in disorganized behavior.

Though in physiology it is customary to refer to the

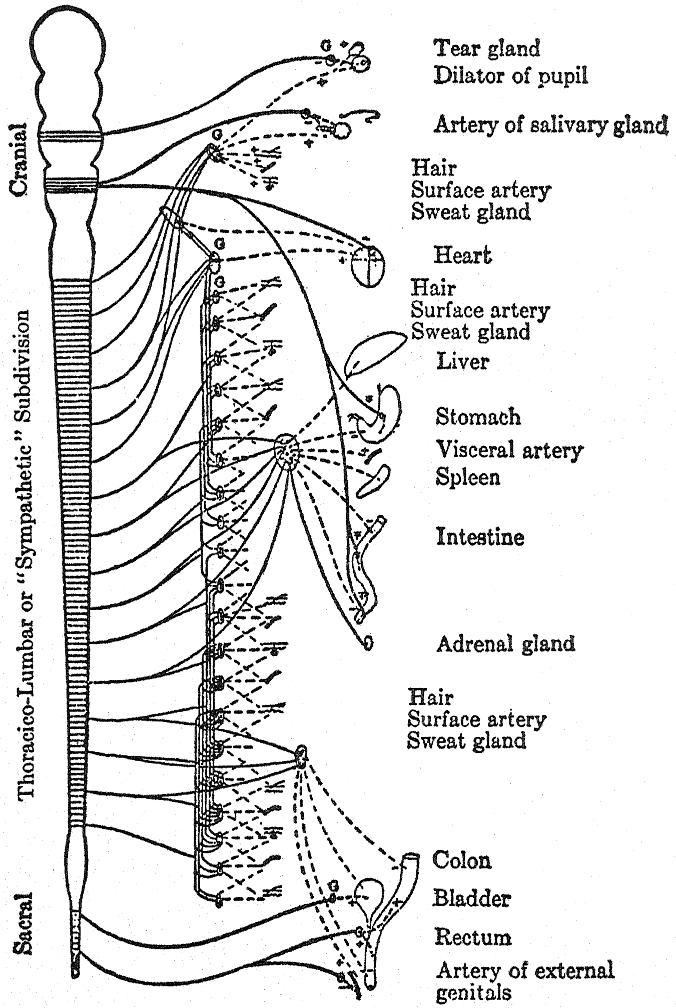


Figure 40.—A Schematic Diagram of the Autonomic Division of the Nervous System. (*Cannon.*)

skeletal nervous system as that portion that supplies the striped muscles, and the autonomic nervous system as that division which is directly connected with the smooth muscles—such as the ciliary muscle of the eye and the muscles in the walls of the viscera and blood vessels—and with the glands, it should be understood that anatomically these divisions are integrated into one complete system, with the brain dominant. In other words, the autonomic nervous system is not exactly autonomous, as its name would imply. Its chief characteristic, however, is to conduct impulses in rather a diffused manner to the internal organs.

**Divisions of the autonomic system.** The autonomic system consists of three divisions. From the brain-stem, nerve fibers are distributed to the tear glands and dilator muscle of the pupil, and by the vagus nerve to the heart, stomach, and other visceral organs. This constitutes the *cranial division*. Along either side of the cord throughout the thoracic and lumbar regions are small ganglia, or groups of cells, which are connected with the cord through the spinal roots and interconnected by a nerve trunk. Still other ganglia are to be found within the diaphragm nearer the visceral organs which they supply. Some nerves from the cord go direct to the visceral organs and some to the various ganglia, and thence the impulses pass by other neurones to the viscera. Through the mediation of these ganglia, nervous impulses may be more widely distributed. This division is generally known as the *sympathetic division*. The third, the *sacral division*, originates in the sacral nerves of the cord and supplies the organs of the lower abdomen (Figure 40).

**Autonomic processes.** The functioning of the autonomic nervous system differs from that of the skeletal system in two important respects:

1. It functions more slowly. This is not wholly due to the slow nerve conduction, but partly to the slow response of smooth muscles.

2. Whereas excitation through the skeletal system is specific, excitation through the autonomic is general.

Excitation of the sympathetic system, for example, results in an increase in heart rate, cessation of digestive activities, an increase in the secretion of glycogen from the liver, and numerous other responses. Another characteristic of the autonomic system is the antagonism between the sympathetic division and the cranial and sacral divisions. The sympathetic overlaps at its upper end the cranial division and at its lower end the sacral division. Wherever an organ is supplied with two divisions, one serves to augment the activity of the organ and the other to inhibit it. Thus, the heart beat is increased by a nervous impulse through the sympathetic division, but is inhibited by a similar impulse through the vagus nerve of the cranial division.

Cannon has clearly demonstrated by experiments upon animals the intimate relation between certain activities of the animals which he considers emotions and the functioning of their autonomic nervous systems. If a cat were fed and then the stomach and intestines were observed by means of the Roentgen ray, it was possible to see the rhythmic contractions in the process of digestion. However, if the cat were in any way disturbed, it could be observed that the contractions of the stomach ceased. This was particularly evident when a dog was allowed to bark at the cat. The cat hissed, bared its claws, and ruffled up its back, which actions Cannon interpreted as signs of anger. At the same time, the rhythmic contractions of the stomach ceased.

**Glands of internal secretion.** Cannon has also shown that certain glands, particularly the adrenals, are very closely related to those activities which he describes as the emotions of fear and rage. The adrenal glands in human beings are about the size and shape of a lima bean and are located just above the kidney. As the blood passes through one of these glands, the secretion is absorbed and carried to other internal organs, where the autacoid of the secretion acts as an exciter or depressor of the organ. As it takes longer for this autacoid to reach any organ than for an impulse through the autonomic nervous system, the response is somewhat delayed.

Cannon found that when this secretion, adrenin, was injected directly into the blood stream of a cat, the animal manifested all the symptoms that are present when the cat has been barked at by a dog. There was an increased heart rate, a cessation of digestion, an increase in blood sugar, and an increased tonus of the skeletal muscles. On the other hand, when the dog was allowed to bark at the cat, an analysis of the blood of the cat showed an increase of adrenin, and the symptoms enumerated were present at the same time.

**Adrenals as emergency glands.** On the basis of these and similar experiments, Cannon concludes that the adrenals are "emergency glands." That is, a situation of danger is a stimulus for vigorous response, which includes, through the sympathetic nervous system, the cessation of digestion and the throwing of the blood supply to the skeletal muscles in order to meet the emergency. At the same time, the sympathetic nerves to the adrenal glands cause an increase in their secretion which reinforces the action through the sympathetic system. From the standpoint of practical considerations, Cannon's conclusion is not difficult to understand. The moment of danger is no

time to digest food. It is more important to draw upon the reserve supply of energy that the organism has stored, and Cannon finds that is what occurs, so far as the physiological functions are concerned.

Cannon, therefore, has clearly demonstrated the function of the autonomic nervous system and of the adrenal glands in situations that result in disorganized behavior. He has also shown that the thalamus, an important integration center below the cerebrum, plays an important rôle in these situations. We may say that in the situation for which we have no ready, organized response the higher control of the integrating mechanism of the cerebral cortex is failing to function adequately. The chief integration is left, then, to the lower center, the thalamus. The result of integration by this center is more violent and less organized nervous impulses, which in turn result in what we have called "disorganized behavior." This description would account for the fact that the behavior that is popularly called "emotion of fear or anger" is more primitive in character than the behavior we exhibit when we meet a situation calmly.

**Visceral responses.** Occasionally, an author refers rather carelessly to "visceral disturbances" in emotion. There is no more reason for referring to visceral responses as disturbances than for saying that we have a muscular disturbance in walking. The visceral reactions are merely a part of the activity of the total response. Similarly, respiratory and circulatory reactions are neither the cause nor the effect of emotion, but are constituent parts of the emotional response. What typifies the emotion is the complete or partial disorganization of behavior. When the response is completely organized, we say that the individual is adjusted to the stimulating situation.

When the athlete takes part in a contest, or the laborer

performs a task that involves great muscular effort, the behavior of neither is characterized by what we would call an "emotion," yet the visceral and circulatory activities are much the same as Cannon found in the case of the enraged cat. Both men perspire; their breathing and heart rates are increased; and if we could observe the visceral reactions under such circumstances, we would find the same types of response. We know, for example, that it is injurious to the digestive system to undertake strenuous physical exercise immediately after eating because of the cessation of the digestive processes under such conditions. The principal difference is that the emotional activity, or disorganized response, is likely to be more vigorous than any ordinary form of labor.

### Questions for Review

1. Under what conditions is emotional behavior apt to occur?

2. In what respect are all emotions similar?

3. What is the relationship between instinct and habit in emotion?

4. May organization and disorganization occur in the same behavior pattern?

5. What part of the nervous system plays an important part in emotional behavior? With what functions of the body is this part of the nervous system concerned? Into what subdivisions has it been divided?

6. What is the evidence that indicates the important part played by the viscera in emotional behavior?

7. What organs function in an "emergency" capacity during emotion? What is the evidence for this conclusion?

8. What are the similarities and differences in the behavior in (*a*) lifting a heavy object and (*b*) reacting to a dangerous situation?

## CHAPTER XVIII

# Experimental Studies of Emotion

**Blood pressure experiments.** A simple experiment which illustrates the truth of the statements made at the end of the last chapter is the determination of the blood pressure of the subject under different conditions of stimulation. This determination can be made by the use of the sphygmomanometer, an instrument which measures the blood pressure in terms of a column of mercury. A rubber sleeve or bag is wrapped around the arm above the elbow. This sleeve is attached by a rubber tube to the mercury column or a dial which registers the equivalent pressure. The sleeve is inflated until the pressure upon the arteries is sufficient to interrupt the circulation. The sleeve is then slowly deflated until with each pulse the blood is just forced beneath the sleeve.

The point at which the blood is forced under the sleeve may be observed by means of a stethoscope applied to the artery below the sleeve. The height of the mercury column at this point measures the maximum, or *systolic*, pressure, which occurs with each heart beat. If the sleeve is still further deflated, there will be reached a point at which the blood escapes continuously beneath the sleeve and the rush of blood can no longer be heard. This point is taken as the minimum, or *diastolic*, pressure (Figure 41).

If the subject remains quietly seated and the pressure and pulse rates are recorded every minute, it will be

found that the pulse and the systolic pressure become slightly lower. After 15 or 20 minutes they remain fairly constant. There is usually little change in the

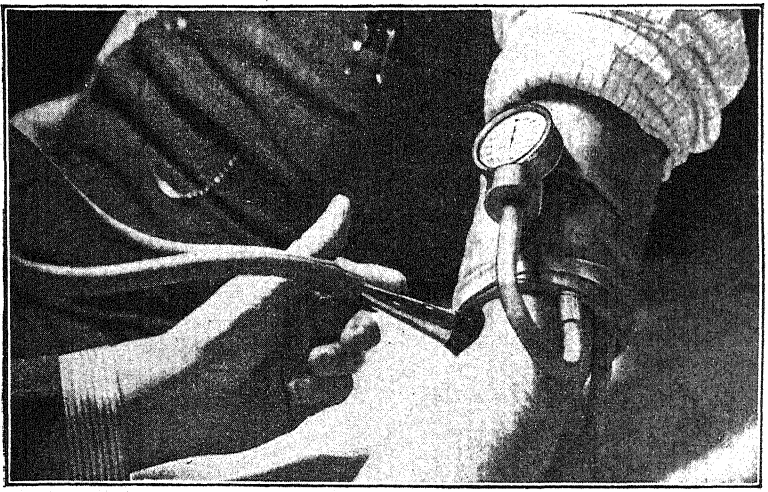

**Figure 41.—A sphygmomanometer used for measuring blood pressure.** In this model, the dial registers the pressure equivalent to a column of mercury. (*Taylor Instrument Co.*)

diastolic pressure. If any slight disturbance occurs at this period—such as a slight electric shock or a loud noise—or if the subject is asked an embarrassing question, the pulse will be found to increase from 2 to 5 beats per minute and the systolic pressure will be increased approximately 10 millimeters of mercury. Frequently, these changes will take place in spite of the declaration of the subject that he has not been disturbed.

If, after the pressure has returned to normal, the subject is required to step up on a chair 5 or 6 times, it will be found that the systolic pressure has again increased about the same amount as in the former instance. Under either condition, the change in pulse rate and blood pres-

sure is about the same, though one might be considered a startle or slight emotion while the other would be classed as ordinary physical work.

We may conclude, therefore, that any increase in activity, whether it is considered an emotion or physical exercise, will lead to a change in blood pressure which is brought about by excitation through the autonomic nervous system.

**Galvanic skin reflex.** Certain electrical changes have attracted considerable attention as possible delicate measures of emotional response when the overt behavior of the subject would not betray the presence of emotion. If two electrodes which are connected with a battery and a sensitive galvanometer are applied to two parts of the body, the galvanometer will show any slight changes that take place within the circuit. These deflections of the galvanometer may be due to either of two causes. The resistance offered at the contacts with the skin may vary as the result of changes in moisture of the skin, or there may be actual electrical currents produced by internal activities.

It has been demonstrated[1] that both changes may occur. The variation in the resistance is the result of the reflex action of the sweat glands in the skin. The change in electric potential is probably the result of metabolic activities in nerve and muscle.

Under the usual experimental conditions, the galvanometer readings are found to vary considerably even when the subject remains apparently passive. This variation may be due to irregularities in the physiological processes or to fluctuations in the behavior of the subject.

[1] Darrow, C. W., "Sensory, Secretory, and Electrical Changes in the Skin Following Bodily Excitation," *Jour. Exper. Psych.*, 1927, Vol. X, pp. 197–226.

Slight movements of the subject, a deep breath, or any slight disturbance will cause a deflection of the galvanometer. It is necessary, therefore, to take into account the extent of the deflections under specific conditions and to subtract from these the normal or usual deflections.

If there are pronounced to the subject single words to which he must respond with an associated word, the deflections are most extensive for words which deal with maladjustments or worries of the subject, such as examinations, inadequate sex adjustments, or financial worries.[2] Whether this method could also be applied to the study of the degree of activity in work situations, such as computation or study, has not been adequately investigated.

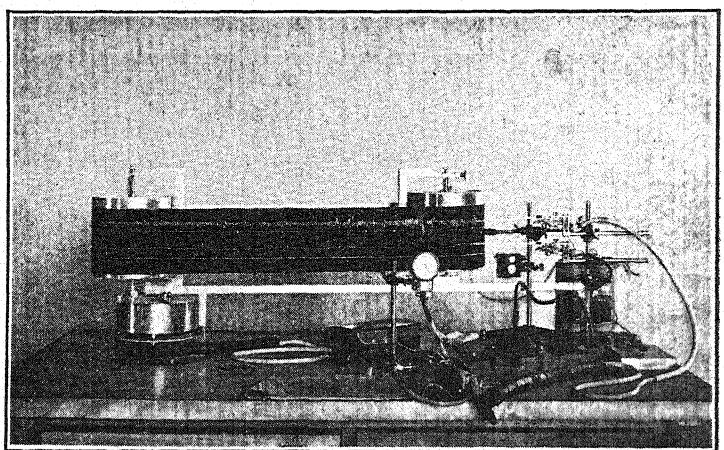

**Figure 42.—Apparatus for recording respiratory and circulatory changes.** The upper line on the smoked paper is the breathing record; the second line represents changes in blood pressure; the third line indicates points at which stimuli were applied or conditions changed; and the lower line indicates the time in seconds.

[2] Syz, H. S., "Psycho-galvanic Studies of Sixty-four Medical Students," *Brit. Jour. Psych.*, 1926–27, Vol. XVII, pp. 54–69 and 119–126.

**Pneumographic studies.** Respiration may be recorded by a pneumograph placed upon the chest. This instrument consists of a hollow rubber tube which may be fastened around the chest and connected to a tambour which records on a moving paper the changes in the volume of air in the tube. Usually one pneumograph is placed high on the chest and a second one on the abdomen. In this way the depth of breathing is also registered (Figure 42).

Under various conditions it is found that breathing may be increased in rate, may vary in depth, or may show a change in the inspiration-expiration ratio—that is, in the relation between the periods of inspiration and expiration. Recently, attention has centered in the inspiration-expiration ratio, which is now considered the most reliable index of emotional disturbance. In the case of disorganized response in emotion-provoking situations, the inspiration-expiration ratio is supposed to be increased.

**Lie detectors.** Several investigators have attempted to use one or more of the above-mentioned methods for the purpose of detecting lying and guilt with reference to a crime. These investigations are based upon the assumption that a subject is more disturbed when telling a falsehood than when telling the truth; that he will be more disorganized when confronted with the facts of some crime if he is guilty than he would be if innocent. The results are not entirely conclusive. The experiments carried out in the laboratory are usually too artificial, though this is not always the case.[3] The so-called "lie detectors"

[3] Burtt, H. E., "The Inspiration-Expiration Ratio during Truth and Falsehood," *Jour. Exper. Psych.*, 1921, Vol. IV, pp. 1–23.

Crosland, H. R., "The Psychological Methods of Word Association and Reaction Time as Tests of Deception," *University of Oregon Publications, Psychology Series*, 1929, Vol. I, No. 1, 104 pages.

consist of assemblies of the same techniques as have been described.

Let us take the case of theft of clothing, a watch, and other articles from a room in a fraternity house. Any one of three members living in the house might have been guilty. After careful investigations of the circumstances surrounding the theft, there was performed an experiment in which eight members, including the suspects, were examined. The technique was as follows:

A list of 80 words having no relation to the crime was prepared. Twenty words which might be directly associated with the crime were added to these at irregular intervals. Each subject in turn was instructed that when a word was pronounced, he should reply as quickly as possible with the first word that the stimulus word suggested. The reaction time for each response was recorded by means of a stop watch. Blood-pressure and breathing records were also taken throughout the experiment. When the results for all subjects were compared, the records of one subject, who later confessed to being guilty, showed marked differences from the others:

1. His mean reaction time in replying to the significant words was greater than for the other eighty words.
2. In three cases the word associated with the significant stimulus word bore directly upon the crime.
3. In two other cases his reaction time was exceptionally long.
4. His blood-pressure record was more irregular than the records of the other subjects.
5. His inspiration-expiration ratio was slightly more irregular than the ratios of the other subjects.

All of these attempts to substitute the scientific methods for the old "third degree" are hopeful, but the problem is so complicated that little success can be expected until more thorough investigations are made. Psychologists are not yet agreed as to just what is being measured in the so-called emotions. We cannot assume that blood-pressure records, breathing curves, and galvanic phenomena are a true index of truth and falsity. When the accused is attempting to recall a date, these records may or may not vary in the same order that they would if he were trying to cover up the truth. Because of its importance and because of its intricacies, the problem is one of the most interesting in present investigations.

**An experimental study of fear reactions.** The following experiment is a good illustration of the laboratory methods employed to combine several measures for the study of reactions to situations which may arouse startle or fear. The subject was seated in a specially constructed chair. Records were taken on three successive days under normal conditions. During the third experimental period, the chair was released without warning, so that the subject was allowed to fall backward, without injury, about 60 degrees.[4]

An electrocardiograph was used to record the heart action. This instrument consists of a delicately adjusted string-galvanometer and a photographic device which records alterations in the position of the string. Since any muscular activity will be accompanied by electrical changes, each heart beat is recorded. Any other electrical changes are also recorded as described above under

[4] Blatz, W. E., "The Cardiac, Respiratory, and Electrical Phenomena Involved in the Emotion of Fear," *Jour. Exper. Psych.*, 1925, Vol. VIII, pp. 109–132.

"Galvanic Skin Reflex." An electrical pneumograph recorded the duration of each inspiration and expiration in breathing.

The inspiration-expiration ratio (I/E) is computed by division of the duration of the inspiration by the duration of the expiration. Thus, in the present study, the normal ratio was found to be .65 to .85. Table VII gives a comprehensive picture of the results.

TABLE VII

A COMPARISON OF THE EFFECTS OF THE INITIAL FALL WITH NAÏVE AND INFORMED SUBJECTS

| *Cardiac Responses* | *Naïve* | *Informed* |
|---|---|---|
| Initial acceleration | 16% | 17% |
| Ensuing retardation | to normal | 14% |
| Secondary acceleration | 10% | 7% |
| Duration of effect | 3 minutes | 2½ minutes |
| *Respiratory Responses* | | |
| Change in rate | 14-11 (20%) | 16-14 (12%) |
| Duration | 5 minutes | 3 minutes |
| Change in index value | .74-2.08 | .80-1.61 |
| Duration | 5 minutes | 3 minutes |
| Inspiratory stimulation | marked | marked |
| *Electrical Responses* | | |
| Degree | marked | fairly marked |
| Duration | 6 minutes | 2 minutes |

It will be seen that the heart rate was increased suddenly as a result of the fall. The rate of breathing decreased, but the respiratory ratio (I/E) increased from .74 to 2.08. This increase is a commonly observed phenomenon in such experiments, though a decrease in the I/E is also reported in some emotional situations.

The general galvanic effects are marked. With less

violent stimulation, the galvanometer deflections are recorded and the extent of the deflection can be taken into account.

**Conclusion.** From the foregoing description of experiments dealing with "emotional situations," we can conclude that (1) a great variety of reactions which are instigated through the autonomic nervous system take place; and (2) these reactions, individually considered, resemble very closely the reactions to be observed in any vigorous physical exercise. If one runs upstairs, there results an increase in breathing, in blood pressure, and in pulse rate. The perspiration causes a lowering of electrical resistance of the skin, which can be registered by the galvanometer. When one is not involved in any overt physical exercise but is "disturbed" by some event or memory while sitting quietly in a comfortable chair, the implicit responses may be intense and thereby be evident in circulatory and respiratory changes. Disorganized behavior, therefore, differs from organized behavior only in the degree of adjustment to the situation.

The chief characteristic of emotion is disorganized behavior. The function of emotion in daily life and the possibility of classifying or naming different emotions will be presented in the next chapter.

### Questions for Review

1. What is the systolic blood pressure; the diastolic blood pressure?

2. What instruments are used to measure the following bodily processes: changes in blood pressure; breathing rate and amplitude; sweat gland activity? What are the names of some of the recording devices used in connection with these instruments?

3. What changes occur in the circulatory system during emotional behavior?

4. What changes occur in the respiratory system during emotional behavior?

5. In what respect are emotional behavior and physical exercise different? In what respect are they similar?

6. What are some of the reasons why data collected from "lie detectors" are sometimes unreliable as far as placing the guilt is concerned?

7. What type of data is collected for purposes of the detection of guilt? If these data are not allowed as evidence in a trial, how else may they be used?

8. What is the chief difference between the data of the naïve subject and those of the informed subject in Table VII?

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Landis, Carney, and Gullette, Ruth, "Studies in Emotional Reactions: Systolic Blood Pressure," in *Readings in Experimental Psychology,* edited by W. L. Valentine, New York, Harper and Brothers, 1931, pp. 159–163.

Skaggs, E. B., "Changes in Pulse, Breathing, and Steadiness under Conditions of Startle and Excited Expectancy," in *Readings in Experimental Psychology,* edited by W. L. Valentine, New York, Harper and Brothers, 1931, pp. 164–177.

CHAPTER XIX

# Emotion in Everyday Life

**Disorganization and motivation.** What can we say of those situations in which the emotion seems to excite the individual to use higher levels of activity or more intensive effort? It is common belief that not only the pleasant emotions, such as love and elation, but even anger, fear, and great bereavement may function to increase the drive toward some set objective. A student may be goaded to do his best because of anger aroused by a professor's sarcasm or because of his fear that he will flunk the examination. The lover turns from his former shiftless habits and becomes a serious, industrious worker. If emotion is a breakdown in the normal processes of adjustment, how can we account for such seeming contradictions as these?

The answer is twofold. First, the breakdown need not be complete, and second, the partial disorganization may, itself, become a stimulating agency. Whether the latter will be true depends upon the organizing power that has been developed by the individual in question. Students often fail in their courses because they have "fallen in love," while others succeed for the same reason.

The importance of training in organized behavior in the face of emotion-provoking situations is excellently illustrated by an account of an exciting episode which illustrates how, in spite of the emotional situation and the resulting excitement, the man was able to "pull him-

self together." The maintenance of organized influences resulted in strenuous activity, but in another individual the reverse might have been true, disorganization dominating, in which case a tragedy would have ensued.

**Motivation in face of danger.** The facts in the case, as reported,[1] are as follows: A short time before breakfast, *R* was sitting alone before the fireplace. Alice, six years old, came in and stood with her back to the fire. She still had on her night garments, and over these she was wearing a flannelette dressing gown. She came a little too near the fire, and without an instant's warning, the whole back of her outer garment was enveloped in flame. At the very instant that *R* saw the flame over her shoulder and heard her outcry, there came the memory of the terrible burning of his sister and another child, together with the "feeling of condemnation of garments of this sort." There was a sudden "automatic impulse to action."

Four main alternative possibilities presented themselves together: to smother the flame within the garment itself; to smother it in a blanket or something similar; to flood the whole with water; and to pull off the garment. The fourth alternative was settled upon as offering the greatest chance of success. His whole action system, he reports, operated for the twofold task of keeping the flame from the child's face and removing the garment by stripping it off over her head. This was accomplished with more hard jerking and hauling than was really necessary, Alice being thrown to the floor as the garment was torn off.

*R* also reports that the burning of his own hands and

[1] Stratton, G. M., "The Function of Emotion as Shown in Excitement," *Psych. Rev.*, 1928, Vol. XXXV, pp. 351–366.

the danger of setting the house on fire were recognized, but they were of minor significance as compared with the main task. He also believes he resorted to rather inarticulate, but vigorous, vocalization.

In this case we find *R* behaving in a fairly organized fashion. He was able to perform the task successfully, to summon his resources for the occasion, though he undoubtedly displayed many uncoördinated and useless movements. Let us assume that his previous training had been different; that, as a child, he had learned to fear fire; that he had never learned to meet new emergencies; and that he had never developed a sense of responsibility for others. His performance in this situation would have been quite different. His behavior would have been more disorganized and less effective. On the other hand, if it had been his business to strip flaming garments off children every morning, he would have been able to perform the task on this occasion with greater precision and less violence. He would not have thrown the girl upon the floor nor resorted to "rather inarticulate, but vigorous, vocalizing."

**Delayed disorganization.** In many situations such as that just described, the individual reacts adequately and with no apparent emotion; but after the crisis is past, the emotional reactions dominate. An automobile driver may react quickly and correctly at a moment of imminent danger and then be unable to drive when traffic is again cleared. In this case it is probable that with the passing of danger, the motive for the highest degree of coördinated activity is no longer present. This removal of the motive for organized response and the realization that an accident was narrowly averted cause a breakdown or disorganization of behavior. Had the danger continued, the

individual might have been able to maintain the adjustment, though it is also possible that the strain might prove too great to be endured for any length of time.

As a young man was driving one evening, a car about one hundred yards ahead of him "sideswiped" another car and turned over. When the young man arrived at the scene of the accident, he found all the uninjured spectators apparently disorganized and helpless in the situation. He took charge, directed the men in lifting the car, and, himself, pulled a girl out from under the car, placed her in his own car, and took her to the hospital, where she was pronounced dead. He then returned home, only to collapse on his doorstep. He declared that up to this time there had been no sign of disorganization or maladjustment in his behavior. The truth of his statement may be doubted, but the facts of the case warrant the belief that the major activities constituted a well-organized response while that was needed. With that situation past, and as a result of fatigue from the strain in making the adjustment, the more complete breakdown occurred.

**Emotion and creative art.** The poet, the musician, and the artist are wont to believe that their emotions motivate them in the creation of their particular works. They believe, many times, that only in periods of great emotional fervor can they create really noteworthy productions. There is an element of truth in this belief. In a highly disorganized state, a person has two advantages. First, disorganization may mean doing many things at random. Out of these random responses may emerge something the artist had not thought of before, and by working in a more and more organized fashion along this line he achieves a work of note.

In the second place, disorganization may mean an up-

set of old, established habits and ways of looking at things. We experience a great love or a great grief and say that we shall never be the same again. Quite true. We have broken, to some degree, with our old selves. We take a new slant on life and the world. It is not the emotion that motivated us, but the goals toward which we were already striving. If we possessed no motives before, we would not find ourselves motivated merely as a result of the emotion.

**Pleasantness and unpleasantness.** Those conditions which are commonly referred to as "pleasant" or "unpleasant" are often confused with emotion. The preceding discussion has dealt only with those disrupted responses which are of a pronounced character. Pleasure and displeasure, on the other hand, refer to those forms of behavior in which there is either a positive or a negative adjustment with reference to the stimulating object but with really no reference to the organization or lack of organization of behavior.

Pleasure or displeasure is a way of making an adjustment to the situation, and the behavior involved is not emotional as long as the adjustment is effective. We say that we like certain foods and dislike others; a student enjoys one subject of study and finds another uninteresting or a bore to him; some people impress us agreeably while others affect us indifferently or are repulsive to us. In these situations, we seek the agreeable forms of stimulation and try to avoid (are negatively adjusted to) the disagreeable. We are emotional in these situations only when we add confusion to our behavior in dealing with them.

However, we *learn* to like new articles of food which at first were decidedly disagreeable to us; the student develops a genuine interest in the subject that at the

beginning he considered an arduous task to be endured; and we develop new habits and make new friends. It is true that we may continue to work at a disagreeable task, or to look at a picture we do not like, but this we do because we are adjusting for some more remote end. A man may play golf because he is positively adjusted to the game itself, or he may play for the reason that he has learned that it will result in a good appetite and the enjoyment of his dinner.

Another reason for inferring that pleasantness and unpleasantness are a matter of adjustment is furnished by the characteristic response to the stimulation of the various receptors. Pain usually initiates a withdrawing response. The normal reaction to sweet is the acceptance of the substance, while bitter sets up a rejecting response. We may become so adjusted to low intensities of these stimulations that we pick at a sore on the skin or press against an ulcerated tooth in order to produce a slight pain.

One may also endure pain with great satisfaction provided it is in some way connected with habits that make it, for him, a successful adjustment. One may undergo severe hardships on a hunting trip because his ability to endure the severe weather is recognized as physical superiority. On the other hand, all sensations which are pleasant at moderate intensities may become unpleasant when the intensities are sufficiently increased. A mild perfume may be pleasant though a negative reaction is evident when the strength of the perfume is greatly increased.

## Classification of Emotions

Any attempt to classify emotions, as we have shown, involves the important difficulty that in so far as any

response is emotional, it is characterized by disorganization, and hence all emotions are essentially very much alike. The names given to emotions usually refer either to the character of the stimulating situation or to the final outcome in the behavior of the individual. Thus, fear refers to the dangerous, or supposedly dangerous, situation and flight. Anger refers to a similar situation, but the reaction is one of attack. It will be possible for us to analyze only a few of the emotions to illustrate the characteristics involved.

**Fear and rage.** We have seen that the emotion of fear is not characterized merely by the response of fleeing or hiding. If a man were pursued by an ugly bull but were easily outdistancing him, he might even be thrilled by the experience. In other words, the situation would be one for which he possessed a ready response. If, however, he were not so sure of his safety, the bull would become a different stimulus, and other responses would be added to the fleeing response. Our fleeing individual might run faster, but he would also be reacting in other ways. Increased glandular secretions and the attendant visceral changes might become so violent that screaming, praying, and even fainting are among the possibilities that might result.

In rage or anger, we meet with the same possibilities. Fighting is usually looked upon as the characteristic anger response, but one may fight for the sheer pleasure of fighting, or because it is a part of one's code. A prize fighter who "loses his head," through either fear or anger, is almost certain to lose the fight as well. Anger is closely allied to fear in that both arise in response to danger. If we can deal with our enemies effectively, by either avoiding them or overcoming them, there is little occasion for emotion. If we cannot avoid them, we may

have to fight them. The emotion, as disruption, is very much the same in either case.

**Love.** The emotion of love is usually associated with sex stimulation. To speak of a sex emotion is again somewhat misleading, for the emotion in this case again is typified by confusion, or disorganized response. Stimulation through the sacral division of the autonomic nervous system and the influence of the sex glands may play the larger part in the behavior, though as emotion becomes more intense, the sympathetic division also assumes an important rôle. The emotion is a general diffusion of activity, but the stimulus is a definite sex object and may involve a definite sex response.

Many of the so-called "emotions" might better be classed as motives or drives. The conditions that set up the responses that are frequently named "emotions of love" may actually lead to such disorganization as comes in the category of emotion. In this case, the emotion is like any other emotion, namely, disorganized response. However, it can more frequently be analyzed as a physiological tissue condition. When the sex object is present, or linked up with the total response, the most adequate description of the emotion is in terms of motive. We may then say that the individual is *motivated* by his own tissue condition and the stimulation of the satisfying object.

**Joy.** Enthusiasm, joy, exultation, exuberance, and ecstasy, as the terms are generally used, seem to represent different degrees of the same emotion. This type of reaction may shade from a mild feeling of pleasure at success or adjustment to a situation to emotion which in its most violent form passes over into the unpleasant. One weeps for joy; he is overcome; he loses his appetite. These reactions would indicate that the emotion itself is

very much the same as the emotions already described. The stimulus situation is different and, in the milder forms, the reaction is pleasant; but too violent a response interferes with our control or normal adjustment, and hence is unpleasant.

**Conditioned emotions.** Watson has found in his study of infants that stimuli that arouse emotions in the young infant are extremely limited. A loud noise, produced by the striking of a steel bar, sudden removal of support, or an abrupt movement produced by jerking the blanket on which the infant was lying caused responses which resemble those which we associate with fear in the adult. When the infant was old enough to observe objects, he still made no "fear" responses to furry animals such as a rabbit, a dog, or a white rat. After the infant had been tested with such animals, a white rat was presented; and each time the infant touched the rat, the steel bar was struck. When this was done, the infant would jump and whimper, or cry. After several repetitions of this experiment, the rat alone was presented. The instant the rat was shown, the infant began to cry. In general, we may infer that when an emotionally exciting object is presented simultaneously with one not emotionally exciting, the latter may after one or more joint stimulations arouse the same reactions as the former.

Young children are not afraid of animals, strange persons, or the dark until these have been associated with stimuli that already arouse in the children a fear response. Watson found that after the infant had been conditioned to withdraw from the white rat, it withdrew from other animals and objects that in obvious ways resembled the rat.

Many of our adult emotional reactions are conditioned in much the same way. A young lover feels a surge of

emotion when he picks up a glove which belongs to "her." We avoid certain places and people because we associate them with an earlier experience of anger. A student was so greatly upset that he could not remain in the classroom whenever he heard the clicking of a typewriter because it resembled the patter of machine-gun bullets on the sheet iron under which he lay wounded during the War.

## Adjustments to Emotional Situations

We hear a great deal concerning the desirability of exercising control over the emotions. The implication is either that we should suppress the emotion or that the intellect should dominate our behavior even though the emotion is present. There is usefulness in these suggestions, but there remains the difficulty that no psychological method of control is furnished to the victim of the undesirable emotion. We have seen that emotion itself is a form of behavior. Therefore, if it is an undesirable type of behavior, the only remedy is the development of an organized response in the emotional situation and the elimination of the emotion thereby. Let us cite a few examples of everyday situations and see what sort of organization may take place.

If you found yourself on the tenth floor of the open steel work of a building under construction, you would probably experience such a violent emotion of fear that it would be impossible for you to walk across a ten-inch beam. Yet structural steel workers not only are not afraid, but take many unnecessary chances, such as lighting a pipe while standing out on a beam in a high wind, or sliding the length of a horizontal beam on an icy morning. That these men do such things is not so much the result of their being "naturally" fearless as it is the

effect of experience day after day in this type of situation, which has developed organized behavior on high beams.

Consider a similar situation which we meet every day. It requires more skill to thread one's way through the traffic at a busy street crossing than it would to walk on a ten-inch beam. Yet we are little disturbed by this situation if we live in the city, and we "take our life in our hands" when we go for an automobile drive on a holiday.

A young man related that as a boy he fainted on several occasions at the sight of blood. When he realized that this was becoming a habit, he took every opportunity to witness blood. He visited meat markets and slaughter-houses, attended exciting and bloody movies, and read anything pertaining to blood that he could find. The result was the development of a complete indifference to bloody situations.

We may therefore state as the first principle of adjustment to emotional situations the following: *Whenever you meet a situation for which you have no adequate, ready response, meet it as best you can and plan to make a better adjustment next time.*

**Substitute responses.** In many instances, it is not feasible to meet the situation directly. Thus, at the death of an only child, a parent may most easily resolve his grief by turning to some definite activity connected with another object. The development of an interest in art, religion, or charity may become a substitute activity for the emotion of grief. In reality, this method may be characterized as avoidance of the original emotional situation, but if the new objective and the resulting behavior are socially acceptable, this may be the most advantageous course to take.

The psychoanalysts apply the term *sublimation* to

substitute behavior, but they use the term in the restricted sense of the deflection of the sex drive to objects or aims of a non-sexual and socially useful character. For example, the young woman who cannot marry the man she loves may become an overzealous charity worker, or she may devote her life to the care of other members of her family.

As a second principle, we may say that *when you cannot make a direct adjustment to the situation, give another motive sufficient attention so that you become organized with reference to a substitute goal.*

## Maladjustments to Emotional Situations

Many times, adjustments are not adequate as viewed by normal social standards. In such cases, the individual may develop habits which we designate mere eccentricities of behavior. Because he is worried, one may bite his finger nails or tap with his fingers on the table. In many cases, however, the maladjustment may be more serious.

**Phobias.** Some persons exhibit intense fear in situations to which the normal individual reacts in a perfectly organized or non-emotional manner. Thus, a person may possess a fear of enclosed places, such as small rooms or narrow streets. He cannot enter a telephone booth. If he goes to the theater, he must sit next to the aisle or near the door. Others exhibit similarly morbid fear reactions to open places, to high places, and to animals, dirt, darkness, water, and so forth. Such behavior is frequently found among the insane, but occasionally an otherwise normal individual may be the victim of a phobia to greater or less degree.

A young lady had since childhood suffered from a phobia of running water. As a child, she would scream

and fight violently when she was forced into the bath. As a young lady, she could not endure the sound of water running from the faucet. When she rode on the train, the curtains had to be drawn for fear that she would see a small stream. She could not explain why these simple, everyday situations should arouse such violent emotional reactions.

Investigation of the history of her case revealed that she had in her early childhood developed intense fear of being punished by her mother. On one occasion, she had disobeyed her mother and as a result had fallen under a small waterfall. The terror of this situation was combined with the fear of the consequences. An aunt had dried her clothes and promised not to tell her mother. So in the confusion of this episode the child had forgotten the major incidents, but had retained the violent reaction to water. When as a young lady she discovered all the facts, she was able to make the proper adjustment.[2]

**Fainting and other reactions.** We have seen that in cases of disorganized behavior a great deal of energy is consumed, and that this emergency is met through the functioning of the autonomic nervous system and the adrenal glands. If this system fails to function properly, the victim of the emotion may faint. If fainting is repeated several times for this cause, or if it brings results satisfactory to the victim, it may become the habitual response. In contrast to the behavior of the student previously cited (page 285), another student fainted in class when the professor described the blood-pressure experiment. He later related that he also fainted on the playground at the sight of blood, but that he had tried

[2] Bagby, English, *The Psychology of Personality,* New York, Henry Holt and Company, 1928.

to avoid blood situations. Instead of meeting the situation squarely and learning to adjust himself to it, he had fostered the fainting response.

If we can judge correctly from literary characters, in Dickens's time it was easy for women to learn to faint in emotional situations, whereas today women are more likely to be motivated to make adequate adjustments.

Shedding tears is one item in disorganized response, and may become conditioned to emotional situations. One young lady would scream at any little startle stimulus and weep copiously whenever a situation became difficult. After she had gone through several laboratory experiments in emotion and had demonstrated normal control, she confessed that she now realized that her previous emotional behavior had been displayed for its effect at home.

## Emotional Tendencies

**Moods.** When one is in good health and well fed and has just received some good news, he is less likely to be angered by an unfortunate circumstance than he is to enjoy a fortunate one, while the disgruntled, hungry, or ill individual does not easily respond in the best way possible to a situation that calls for favorable conduct. We say that the one is in a disagreeable mood and that the other's mood is friendly. Our moods are determined very largely by what we have been doing and how well we have been meeting situations. The man who has been irritated at the breakfast table may be cranky when he gets to the office. If he has met many troublesome problems during the day, he may be irritable when he returns home. Again, one may develop an habitual mode of response. Thus, some persons are nearly al-

ways in a pleasant mood, others are always grouchy, and still others seem always to be looking for something sad to happen. Moods, therefore, may be characterized as tendencies to emotional reactions. They are emotional attitudes.

**Sentiments.** We have described emotion as disorganized response. Doubtless you have believed that this is true in the case of the more violent emotions but have not been wholly convinced that this type of response is made in all emotional situations. This confusion is owing largely to the fact that we ordinarily use a single word to express more than one meaning. The youth loves the maid; he also loves his parents, his university, and his country. Certainly the behavior classified as "love" is not the same in all these cases. When love may be described as disorganized behavior, it is emotion. When it is a systematic, organized type of behavior with reference to some object or person, it is more properly a sentiment.

Sentiments may have their origin in emotional behavior, but they are outgrowths of the organizing process and may be the result of several emotions. The old grad returns to the university full of sentiment for the old places, his class bench, the spring, or the old dormitory. Here he studied, there he loved, and over there he met his first great grief. These are all organized now into a mode of reacting.

You may love your country and yet have never experienced a patriotic emotion. This is your home. You have seen your country in danger from enemies within and without its boundaries. You have learned to make your adjustments in this kind of society. You are getting on very well. All of these experiences contribute to your patriotic sentiment.

**Emotional fringe.** That there is a bit of thrill or anger or excitement in most of our organized behavior need not worry us. No one would care to be totally organized in all his behavior. Our behavior is like the food we eat. Good, plain food and a balanced diet are essential to health, but we get more enjoyment out of eating if the food is spiced up a bit and a dessert follows. A diet of fancy foods and rich desserts would be ruinous. So it is with our behavior. We must learn to make satisfactory adjustments to everyday situations. This is our most important problem. However, when our work is going well, we experience a slight thrill of excitement. If it goes poorly, we are slightly disturbed. These mild disorganizations on the fringe of our central activity are the "spice" in our behavior. After the task is finished, we seek excitement. Life would be dull and monotonous if it consisted only of perfectly organized behavior. It would be worthless if the major portion were dominated by disorganized or emotional behavior.

### Questions for Review

X 1. Under what conditions may disorganization increase motivation? When will it decrease motivation?

X 2. Cite some instances in your own experience in which the disorganization occurred some time after the emotion-provoking situation. What prevented the emotion from occurring sooner?

3. Is the work of the artist under an emotional "inspiration" apt to result in something new to him, or is it more apt to be a repetition of more familiar behavior patterns? Why?

4. What is the evidence that pleasantness and unpleasantness are forms of learned behavior? What constitutes a "painful" stimulus?

5. Upon what bases may emotions be classified?

6. What are some of the situations with which an infant may come in contact that will facilitate the occurrence of emotional behavior?

7. A friend complains of being "deathly afraid of high places." How would you go about remedying this condition?

8. What would be your advice to a person whose appearance will always be a handicap to him in social situations?

9. Why may it be true that women are more apt to faint than men?

10. How are moods to be considered? Can you make a classification of moods?

11. Should we make it a point in our educational program to eliminate all emotional behavior by a proper training of children?

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# BOOK II

## SECTION VII. SENSORY DISCRIMINATION

XX. Visual Discrimination
XXI. Auditory Discrimination
XXII. Discriminations of Touch, Movement, and Equilibrium

References to Student's Guide:

Exercise 54. The Accuracy of Tactual Localization
Exercise 55. The Discrimination of One and Two Points on the Skin
Exercise 56. Factors in the Discrimination of Distance
Exercise 57. Discrimination of Depth through Disparate Images

## CHAPTER XX

# Visual Discrimination

In Book I we have studied the general principles of the development of human behavior. We have seen, for example, that man has been able to reach a higher level of living and thinking, of coöperation in a complex society, than the lower animals because throughout the evolutionary process he has been fortunate in evolving structures that make possible a variety of responses which are unattainable by any lower animal. We have pointed out how he has been able to use these structures in the adjustment to and mastery of his environment.

The life of each individual is one continual struggle in orientation to his physical and social world. We have seen that physiological conditions and contact with the world about him have led to the development of motives and higher ideals of a socially acceptable character. This growth includes a continual process of learning which we have described as "the organization of behavior."

It now becomes our task to study in greater detail some of the more important problems connected with learning to make organized adjustments to the environment. In Chapter VII we have briefly described and classified the receptors through which the human individual is affected by stimuli in his environment, and in Chapter XIV we have further described the organization of sensory data into patterns which we call "perceiving."

We have pointed out that the eye is a remarkable mechanism in which, as a receptor, we discover interesting phenomena in connection with seeing colors and with adaptation to colors and to gray. Another very important fact is that we are able to develop spatial relations which, although involving many factors, can be attributed to one eye alone, and others which employ both eyes in coöperation. These phenomena, of course, are all based upon the fact that we have had various experiences with the objects. It is advisable to review at this point the description of the eye and visual phenomena.

## Distance Discrimination

The eye is frequently called a "distance" receptor because we refer the stimulus to an object which is not in direct contact with the receptor, and because we are able to discriminate visually how far an object is from us or which of two objects is farther from or nearer to us. We are so accustomed to seeing objects that we generally fail to realize that this discrimination is a psychological problem. "We just see the object as out there," we say.

That our differential responses are *learned* may be admirably illustrated by a consideration of our spatial discriminations. In those types of organized responses which are designated "perception," not alone is the reaction made to a single stimulus acting through one sense modality, but the responses resulting from other stimuli have been conditioned to this stimulus as it occurred with these other stimuli. Thus, a brick "looks" heavy. We have previously lifted a brick that we have seen. Now the visual stimulus is so definitely associated with the tactual and kinesthetic responses that we "see" it as heavy.

The substitution of one sense modality for another is particularly evident in the case of distance discrimination. That book upon the table is farther away from me than the blotter. It would require a greater movement to reach it than to reach the blotter. The accuracy of our discrimination of distance, therefore, is dependent upon a combination of factors, some of them specifically visual, some of them responses of adjustment at the moment of seeing the object, and still other responses in other sense fields that have occurred on previous occasions.

**Factors in space discrimination.** (1) *Relative size.* We see familiar objects without much variation in size, regardless of the distance they are from us. Actually, the size of the image in the retina is decreased, but we have learned to interpret this change in size as a change in distance. A man looks as tall when he is 20 feet away as when he is only 10 feet away. What we familiarly know as perspective is a good example of this fact. We represent the more distant objects in a picture by drawing them smaller than the nearer objects and by making receding parallel lines in them converge.

(2) *Relative distinctness.* Similarly, we have learned that the relative distinctness of objects furnishes a cue to their distance. Far-away objects are less distinct than near-by ones. An interesting illusion often occurs when one visits the mountains for the first time. Objects miles away appear to be near at hand. As one becomes accustomed to the clearer atmosphere, distances take on their usual proportions. The painter makes the background in a painting appear at a greater distance by having it less distinct.

(3) *Vertical position.* The arrangement of objects in the visual field is another factor which we seldom recog-

nize and which yet can be easily observed. The more distant objects below the line of the eyes are above the nearer objects, while distant objects above the line of the observer are lower than the near objects. The more distant chairs in the room are seen as above those that are nearer, and the lamps in the ceiling reverse this arrangement.

(4) *Intervening objects*. This tree is nearer than that house behind it. It is a hundred feet to the tree, and so forth. The importance of intervening objects is illustrated by our inability to estimate with any degree of accuracy the altitude of an airplane, as in the air it is removed from all other familiar objects. On the deck of an ocean liner, a group of passengers were discussing the distance to another steamer. Their estimates varied from 500 feet to 2 miles. None was familiar with the

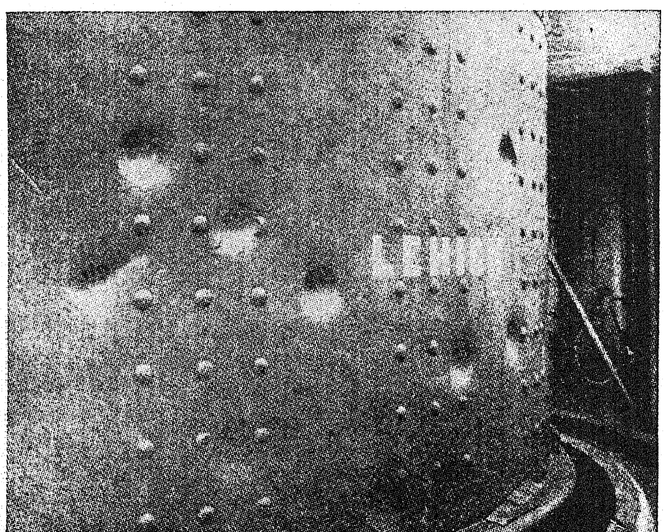

**Figure 43.—The Influence of Shadows.** (*After Titchener. C. H. Stoelting Co.*)

size of ocean liners. The waves, the only surrounding cues, also were unfamiliar to them, hence their wide divergence in estimating the distance.

(5) *Shadows.* We have learned that certain shadows are due to projections and others to depressions of the surface of the object. We know, for example, that the light falls upon the object from a certain direction. Therefore, the shadows indicate the projections and depressions of the object's surface. We see this effect in the illusion obtained with a picture in ambiguous perspective. In the photograph in Figure 43, depressions are seen when the picture is held in one position; but when the picture is turned upside down, these depressions appear as bulges. Most frequently the light comes from above, and the shadows are accordingly on the under side. We interpret this picture according to such past experiences.

(6) *Movement.* Moving objects close at hand pass over the field of vision more rapidly than objects at a greater distance moving at the same rate. This phenomenon is also closely related to the size of the field of vision. A train or airplane at a distance appears to move slowly because it is passing over a greater field though the area of the retina stimulated may be the same. Speed of movement, therefore, becomes a factor in our judgment of distance (Figure 44).

**Accommodation for near and distant objects.** The optical mechanism has frequently been compared to the camera. In the camera we have the sensitive photographic film and the system of lenses which focus the light rays sharply upon this film. If the object to be photographed is close, say 6 feet away, the lens is drawn forward to a greater distance from the film. If the object is 20 feet away, the lens is moved toward the film.

Beyond a hundred feet, the distance between lens and film need not be altered. We could, of course, substitute lenses of different curvature for the various distances, but this is inconvenient.

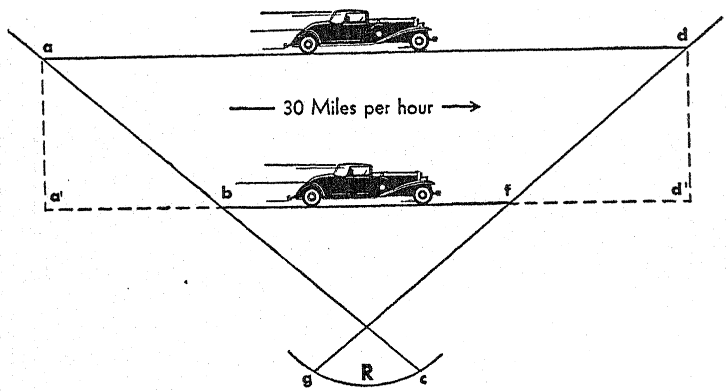


**Figure 44.—Illustrating the Influence of Moving Objects in the Discrimination of Distance.**

In the eye, the retina corresponds to the sensitive film of the camera, and the cornea and lens to the refracting system (1 and 4, Figure 18, page 92). It is commonly assumed that the refractive power of this system is altered by a change in the curvature of the lens. That would be similar to inserting into the camera lenses of different curvature. Around the lens is the ciliary muscle (3, Figure 18), which is attached to the edge of the lens by fine ligaments. When the muscle is relaxed, and therefore narrow in cross section, tension is exerted upon these ligaments and the lens is drawn out flatter. This flatness would be the condition for distant vision. For near objects, the muscle contracts and allows the lens to assume its natural form of greater curvature.

When we look at a near object, we experience sensa-

tions of strain. When we have been reading for some time, we look across the room to rest our eyes. These sensations of accommodation are cues for the discrimination of distance, but they are not effective for distances much greater than 20 feet.

**Convergence as a factor in distance discrimination.** All of the factors enumerated thus far apply to one eye equally as well as to two eyes. However, the functioning together of the two eyes is of extreme importance. We have noted (page 128) that in the young infant the eyes may move independently of each other, but that eye coördination is rapidly acquired. When we fixate an object with one eye, the other turns to the same point. If we fixate a distant object, say, 100 feet away, each eye is turned in toward the nose very slightly. If the object is only 10 feet away, the convergence is increased.

The movement of the eyes is controlled by a set of muscles attached to the outer coat. The contraction of the inner ones turns the eyes toward the nose; that of the outer muscles turns them in the opposite direction away from the nose. Similarly, another pair of muscles turn the eyes up or down. A third pair of muscles set at slightly oblique angles cause a rotary motion. The sensations caused by the contraction of these muscles in fixating an object furnish cues as to the distance of the object. The nearer the object, the greater is the muscle strain.

The result is a considerable improvement in discrimination over the functioning of one eye alone. If, for example (see Figure 45), two vertical rods are set up against a uniform background 20 feet in front of the observer, and one rod is slowly moved forward until he can say that it is nearer, when the observer is using only one eye the rod must be moved a foot or more before this

discrimination is made. With both eyes fixating the rod, a difference as small as 1 inch may be detected. Convergence is a factor in distance discrimination up to approximately 300 feet.

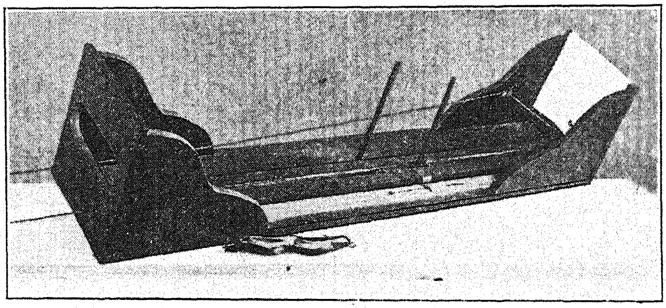

**Figure 45.—Apparatus for Measuring the Discrimination of Distance.**

**Retinal disparity.** The most important factor in the functioning of the eyes in the estimation of distance is the fact that what we see with one eye is not quite the same as what we see with the other. If we hold the head in one position as we look at several objects before us, first with one eye closed and then with the other closed, we can observe that the arrangement of the objects with reference to each other is not seen the same with both eyes. The stimulations fall upon non-corresponding points of the two retinas, producing *disparate images*.

The function of disparate images is illustrated nicely by the following laboratory experiment. A frustrum of a pyramid is set up before the subject with the small face toward him. He makes two drawings of this frustrum, side by side, with the centers of the two drawings approximately 3½ inches apart, the normal distance between the eyes. The left-hand drawing in Figure 46 illustrates the object as the subject sees it with the left

eye, and the right-hand drawing, as he sees it with the right eye.

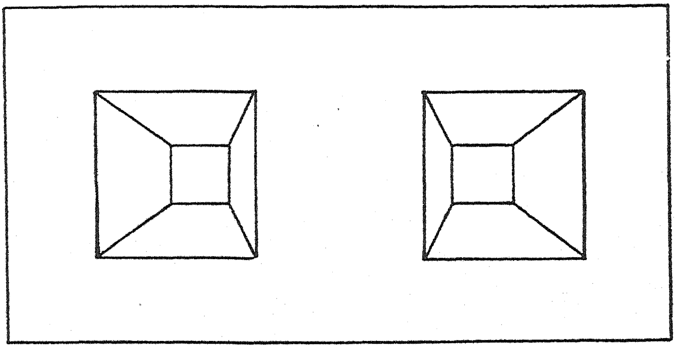

**Figure 46.—The Two Views of the Frustrum as Seen With the Left and the Right Eye.**

If these drawings are made upon glass, the subject may fixate a distant point (100 feet) and, without changing his fixation, slip the glass up before the eyes so that each

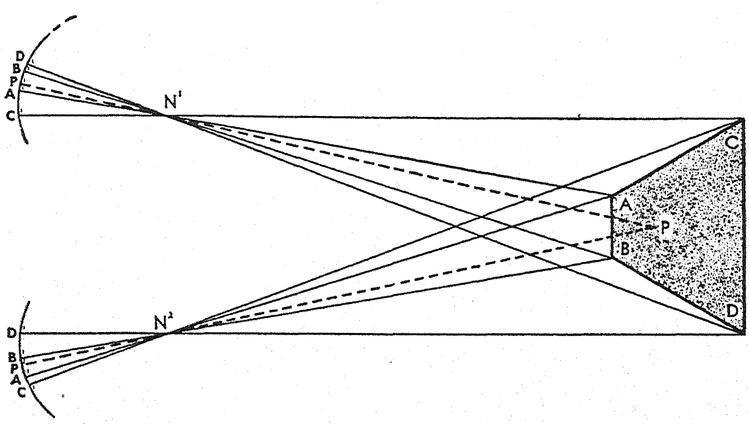


**Figure 47.—Diagram illustrating how each eye is stimulated by the light from the frustrum.** The broken lines represent the lines of regard; the unbroken lines represent rays from *A*, *B*, *C*, and *D* stimulating points A¹, B¹, C¹, and D¹ in one retina and A¹, B¹, C¹, and D¹ in the other.

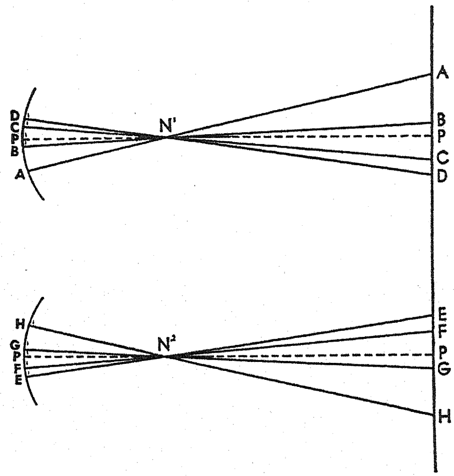


**Figure 48.—Diagram Illustrating How Each Retina Is Stimulated by the Drawings, as in Figure 47.**

drawing comes before the corresponding eye. Both eyes will then be stimulated as they were when looking at the original object. With a little practice, the subject will discover that the two drawings merge into one with the small square in front of the larger one. The appearance of depth is produced by the disparate images, in spite of the fact that the eyes are not converging as much as they would if looking at the actual object. Figures 47 and 48 show how the same stimulations are brought about in the two situations.

**The stereoscope.** If two prisms are properly placed one before each drawing of Figure 46, the images are so deflected that the retinal points stimulated in each eye are the same ones that would be stimulated if the subject were looking at the object (Figure 49). This is the principle of the stereoscope, a simple little instrument that a generation ago was to be found on every library

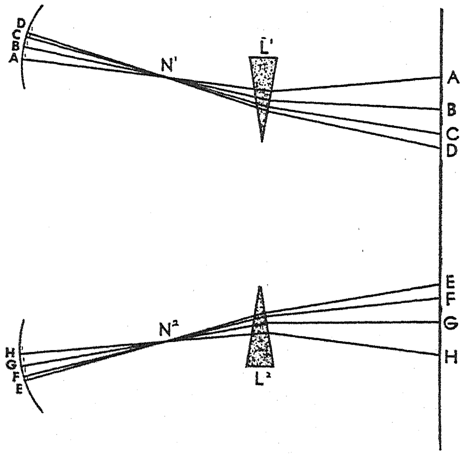


**Figure 49.—The function of the stereoscope.** The images *A, B, C,* and *D* and *E, F, G,* and *H* are deflected by the prisms $L^1$ and $L^2$ so that the rays fall upon the same parts of the retina as in Figure 47.

table (Figure 50). The stereoscopic view is made by a double camera, which photographs the scene from two

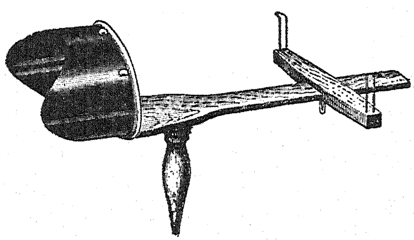

**Figure 50.—The Stereoscope.** (*C. H. Stoelting Co.*)

slightly different angles, just as the two eyes would see it. An examination of the two pictures in Figure 51 will reveal that they are slightly different. Though either view shows depth to some extent, owing to perspective, relative clearness, shadows, and so forth, the depth of the picture is greatly increased when the double picture is viewed through the stereoscope. It is estimated that

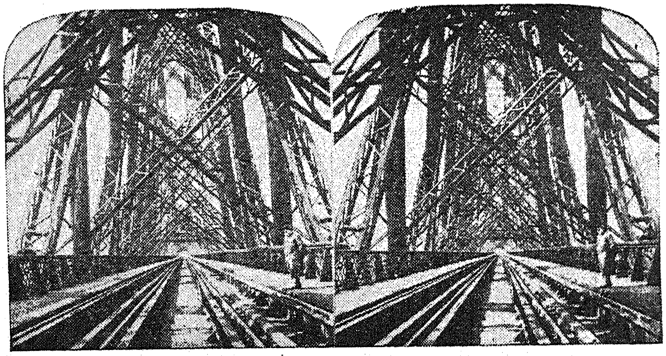

Figure 51.—A Stereoscopic View. (*C. H. Stoelting Co.*)

disparate images are effective in the discrimination of depth or distance up to approximately 2,500 feet from the object.

## The Function of the Eyes in Reading

Reading involves a great deal more than the functions that come under the head of sensory discrimination; yet, the problems of clear vision, eye fatigue, and numerous types of sensory defects are so important that it is advisable to treat them in a special section. Many students find that one of their chief difficulties is either the necessity of laboring under the severe handicap of eyestrain or the inability to read all the assignments in the time at their disposal. Some of these difficulties are due to defects of the optical mechanisms, some to inadequate illumination, and still others to the fact that the student either has not learned how to read or is naturally slow in comprehension.

**Visual acuity.** We have already described the mechanism (page 299) whereby a clear image is focused upon the retina. If we wish to determine the limits of distinct vision, we set up two lines or dots at a given distance

from the eye and move them closer and closer together until we discover the nearest distance between them at which we still see them as two. This "two-point limen" is found to be such that it subtends an angle of approximately 1 minute. For practical purposes, test charts composed of letters are generally used. Each letter is so designed that each section of it subtends this angle when the chart is placed at the proper distance (Figure 52). It is usually convenient to set the test chart at a distance of 20 feet. If the subject can read the letters of the size that subtends an angle of 1 minute, and no smaller letters, he is given a rating of 20-20. If he can read only those letters at 20 feet that should be read at 30 feet, his rating is 20-30. Some individuals at a distance of 20 feet can read letters that at 10 feet subtend an angle of 1 minute, thus securing a rating of 20-10.

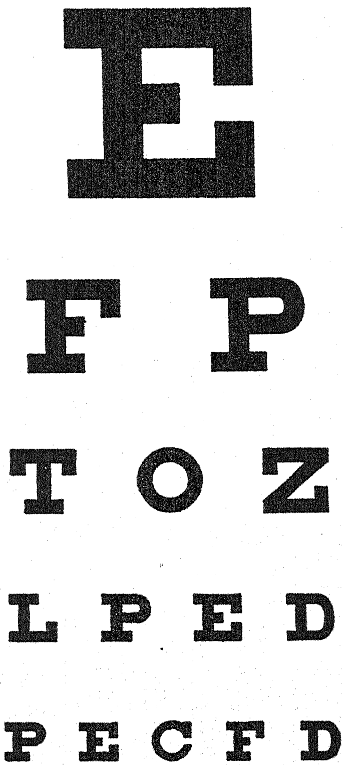

**Figure 52.—Test Chart.** (*Modified from Snellen's.*)

**Defects of vision.** Inability to read letters at the normal distance may be due to the fact that the curvature of the surfaces of the lens and the cornea is too great and the rays come to a focus in front of the retina, producing *myopia*, or "near-sightedness." On the other hand, the curvature may be less than normal, in which case *hypermetropia*, or "far-

sightedness," results. The lenses of spectacles correct these defects by furnishing a sufficient amount of curvature to compensate for the abnormal curvature of the lens and cornea of the eye.

Another defect is *astigmatism.* In the normal eye, the refraction surfaces are spherical; that is, the curvature is the same in every meridian. In the astigmatic eye, this curvature is greater in some meridians than in others. Hence, vertical lines might be in focus while horizontal lines would be out of focus. For the normal eye, all the lines of Figure 53 would appear equally distinct and black; for the astigmatic eye, some would be black and others would be indistinct and lighter gray.

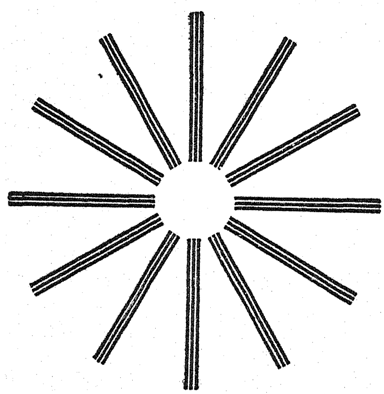

Figure 53.—Chart for Testing Astigmatism.

**Visual defects with age.** Usually, as one approaches the age of forty, he finds that even though he can see objects distinctly at a distance of 20 feet, he is unable to read ordinary-size print at the distance of about 16 inches. This is so because the lens has lost its elasticity and consequently the curvature is not increased for near distance. For this reason it is necessary for the person

of this age to wear glasses for reading. If the individual already wears glasses, he usually must now wear two sets of lenses, one of them a small segment set into the larger lens to correct his near vision while the larger lens corrects the defects of his distant vision.

**Eye movements in reading.** If we observe the eyes of a person while he is reading, we can note that they move from one side of the page to the other not smoothly, but by a series of jerks and brief pauses. It has been established that during the jerks the eyes are moving so rapidly that the printed page must be too indistinctly seen to make discrimination of the words possible. What we can read, therefore, is limited to the duration of the fixation pauses. It is as though short sections of the line were exposed in succession before our eyes. The discovery of these eye movements and fixation pauses has led to several problems of investigation:

1. How many fixations occur in reading a line of a given length?
2. Is there any relation between the number of fixations or their duration and the speed of reading?
3. Are the fixations sufficiently close together so that all of the line is eventually seen? That is, does the span of clear vision to the right of one fixation reach the span to the left for the next fixation, or is there a gap between in which words or letters are not actually seen, but are filled in by our knowledge of the subject?

Several devices for recording and measuring eye movements have been used. The most successful consists in photographing the eye, that is, projecting upon a white spot attached to the eye a beam of light which is reflected to a moving, sensitive film and traces a line corresponding to the fixations on the printed material being read.

In one such study[1] the eye movements were recorded while the subjects read a selection set up in lines 67 millimeters long. Table VIII shows the results of this experiment. There was also found a marked correspondence between the speed of reading and the duration of the fixation pauses. In general, the shorter the pauses, the faster was the reading. On the basis of these and similar results, it is concluded that we may group readers

TABLE VIII

EYE MOVEMENTS IN READING. THE TABLE SHOWS THE AVERAGE NUMBER OF FIXATIONS OR PAUSES PER LINE FOR EACH SUBJECT, THE AVERAGE WORD-SPAN PER FIXATION, AND THE AVERAGE DURATION, IN FIFTIETHS OF A SECOND, OF EACH FIXATION. (Adapted from the data of Miles and Bell.)

| *Subj.* | *Av. Fix. Per Line* | *A.D.* | *Av. Word-Span Per Fixation* | *Av. Duration of Fixation in 1/50 Sec.* | *A.D.* |
|---|---|---|---|---|---|
| 1 | 6.3 | 1.2 | 1.1 | 12.1 | 4.0 |
| 2 | 5.7 | 1.7 | 1.3 | 15.8 | 4.5 |
| 3 | 6.2 | 0.9 | ... | 10.8 | 2.2 |
| 4 | 4.7 | 0.6 | 1.3 | 14.3 | 3.4 |
| 8 | 5.2 | 0.5 | 1.5 | 12.9 | 1.8 |
| 9 | 6.3 | 1.1 | 1.5 | 13.7 | 3.0 |
| 10 | 5.3 | 0.8 | 1.4 | 11.9 | 3.2 |
| 11 | 5.4 | 0.9 | ... | 14.5 | 4.4 |
| 12 | 6.8 | 1.0 | 1.0 | 13.5 | 2.9 |
| 13 | 6.1 | 0.9 | 1.1 | 15.8 | 5.5 |
| 15 | 5.7 | 0.4 | ... | 12.5 | 2.4 |
| 16 | 6.5 | 0.8 | 1.0 | 14.0 | 3.1 |

into four types: (1) those who make a large number of fixations of long duration—these are certain to be slow readers; (2) those who make a large number of fixations of short duration—these are generally slow; (3) those who make fewer fixations but of long duration—these are

[1] Miles, W. R., and Bell, H. M., "Eye-movement Records in the Investigation of Study Habits," *Jour. Exper. Psych.*, 1929, Vol XII, pp. 450–458.

generally fast readers; and (4) those who make few fixations of short duration—these are the most rapid readers.

Investigations of the span of vision in reading or of the distance on either side of the fixation point within which the letters can be distinctly seen indicate that we are able to see clearly all of the material read. In fact, the successive spans overlap considerably. More rapid reading is generally acquired by practice in reducing the number of fixations per line. This rapid reading is usually followed by a reduction in the duration of each fixation. Such reading, however, should not be confused with "skimming" a page. For effective reading at higher speed, greater attention or alertness is necessary, as well as more rapid eye movements.

### Questions for Review

1. What is the evidence that visual space discriminations are learned?

2. List the factors in distance discrimination in the order of their importance or the order in which they are used most frequently.

3. Why do moving pictures give the illusion of depth more easily than still pictures?

4. What will have to be accomplished before stereoscopic vision in moving pictures will be possible?

5. What are some of the more frequent defects in vision? What structures are responsible for these defects?

6. What may be the causes of eye-fatigue after continuous reading?

7. According to the data in Table VIII, what was the average number of fixations per line for the 16 subjects used? Would this average be increased or decreased for unfamiliar material, such as a foreign language?

8. What does the fact that the average reader fails to see many typographical errors indicate regarding reading habits?

## CHAPTER XXI

# Auditory Discrimination

Like vision, audition is of outstanding importance in our social life. Before the invention of written symbols for use as language, vocal transmission and auditory reception were the major constituents of social intercommunication. Manual and facial gestures were used to a limited extent, but the range of possible signals which could be devised for use through these processes is extremely small in comparison to the number of possible combinations of vocal sounds which can be discriminated orally in the form of articulate speech. All important communication between different groups of people was by the mouth-to-ear method.

Written language has advanced civilization primarily on the basis of permanent and accurate recording of events and by providing an inexpensive and efficient method for one or more leaders to extend their social influences to all strata of society—even to all parts of the world—and both to contemporaries and to future generations.

Spoken language, however, will never be supplanted by written. Talking to a person, either directly or over a telephone, is much more personal and effective than communicating through writing. The radio has become an important instrument for both practical and esthetic aspects of our activities derived through auditory discrimination.

An important advantage which our capacity for auditory discrimination yields is that we do not need to orient ourselves to the sound source in order to make the discrimination. Many events which occur in the "visual" world about us escape our attention because we are not *looking* in that direction; but whenever anything happens in the "auditory" world that is of sufficient intensity, we may react to it regardless of our spatial orientation. Sometimes, however, owing to our particular set, or preoccupation, we do not discriminate auditory events that are above the ordinary threshold of hearing.

There are numerous minor auditory discriminations that we make day by day and that form an essential part of our social behavior. If we were not in possession of auditory organs capable of exceptionally minute discrimination, we could not make use of these cues, and, consequently, our social behavior would be not only less complicated but also less efficient. For instance, another person may speak the same words in a great variety of ways, and on the basis of slight auditory discriminations of differences in these sounds our whole interpretation of the attitude of the other individual rests. That such factors are effective on a strictly oral basis apart from facial expression and bodily posture is indicated by the fact that even over the telephone we make such discriminations.

We may be in the presence of a number of individuals talking; there may be noises from vehicles passing on the street or sounds from instruments and machinery; still we can discriminate cues of significance to our particular interests that are much weaker in intensity than most of the others occurring at the time. A skilled choral director may be listening to one hundred voices singing six-part music and be able to detect one person

singing off pitch. Thus, not only can we discriminate a large number of sounds occurring simultaneously, but we can also analyze the complex into discrete and minor changes to which we may react directly and separately.

**The auditory stimulus.** In order to make clear how we make auditory discriminations, it will be helpful to describe in some detail the auditory stimulus which is caused by the vibration of some elastic body which, under ordinary conditions, produces in the air a series of *alternate condensations and rarefactions* which are transmitted by the air to the ear, though any elastic medium may conduct these sound waves. Suppose that a steel rod is clamped to the table at one end. If the free end is pulled to one side and released, it will swing forward and backward in pendular motion. As it swings forward, it condenses the air particles immediately in front of it, and these, in turn, condense the next particles. Thus a wave of condensation moves forward from the rod. But the rod immediately begins the backward swing, leaving a rarefied space which draws back the displaced air particles, and these, in turn, produce a wave of rarefaction which proceeds forward behind the wave of condensation. As the rod continues to vibrate, condensation and rarefaction succeed each other.

If the rod vibrates slowly, the distance from the center of one condensation to another would be greater than it would be if the vibrations were more frequent. Sound waves travel approximately 1,100 feet per second. Therefore, if there are 100 vibrations per second, the distance from the beginning of one condensation to the beginning of the next condensation—one complete oscillation—would be 11 feet. If the vibration frequency is greater, the wave length will be less. It is usual to speak of a *cycle* as a complete oscillation from rest to

the extreme excursion in one direction, back to the opposite position, and then to rest again. The distance the alteration in the air particles has gone in the same period is known as the *wave length.*

For convenience, it is customary to represent a simple sound wave as a periodic curve, such as the *sine curve* in Figure 54. During the time *AB,* the pressure is increasing, attaining a maximum value at *B*; from *B* to *C* the pressure diminishes, attaining at *C* the same

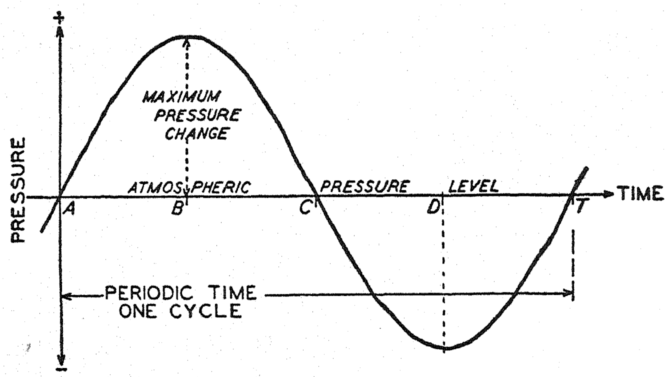


**Figure 54.—Sine Curve Representation of Pressure Variation.**
(*Valentine, "Readings in Experimental Psychology."*)

pressure that existed at *A*. The difference between atmospheric pressure (*A* or *C*) and the pressure attained at *B* represents the *amplitude* of the sound wave and determines the intensity, or energy, of the sound for any specific frequency. From *C* to *D* the pressure diminishes below the atmospheric pressure level. The curve *AT* represents one *cycle* of the sound wave. The frequency is denoted as the number of cycles per second. For example, middle *C* on the musical scale has a frequency of 256 cycles. The frequency, or number of cycles per second, closely corresponds to what we call the *pitch* of a tone.

Thus, a tone produced by 250 cycles is higher in pitch than one produced by 128 cycles.

**Compounded pressure variations.** All the pressure variations caused by ordinary disturbances in nature are compounded waves. Single sine waves can be produced, but only under rigorously controlled laboratory conditions. Compound waves which have a periodically recurring wave form, such as that shown in Figure 55, may

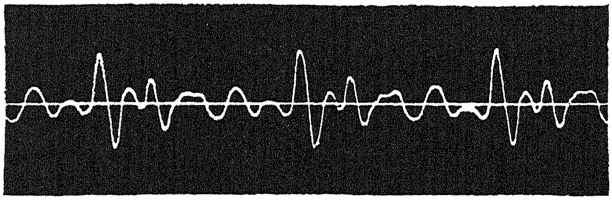

**Figure 55.—A Curve Representing the Compound Sound Wave Generated by a Bass Voice Singing the Vowel *a* as in *Father* on the Note F (frequency level, 92 cycles).** (*From Miller, "The Science of Musical Sounds," p. 205*).

be analyzed physically and mathematically into a discrete number of simple sine waves occurring simultaneously. These components of the compound wave differ from one another in amplitude and frequency, and correspond to the *partials* of a complex tone, the partial with the lowest frequency being the *fundamental.*

Ordinarily, we do not directly discriminate the partials, but we can easily distinguish between the same note of the musical scale when it is produced by two different instruments, say the violin and the trumpet. While the fundamental is the same in both cases, the frequencies and amplitudes of the components are not the same.

**Thresholds ~~for loudness.~~** Until recently, it was not possible to control the frequency and intensity of vibra-

tions to a sufficient extent to make quantitative measurements with the exactness that was possible in the case of vision. With the development of electrical circuits, which involve the same principle as that applying to the common radio circuits, measurements of this sort have been made possible.

Figure 56 represents the stimulus intensity necessary

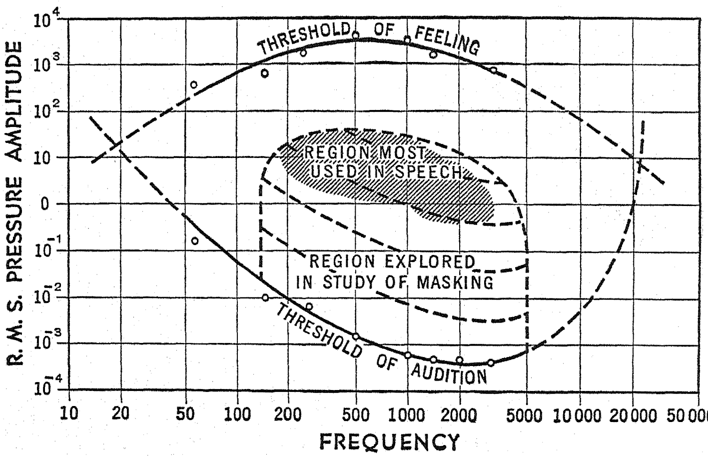


**Figure 56.—Upper and Lower Thresholds for Loudness as a Function of Frequency Level.**

to produce a just audible sound (of initial threshold) at the various frequencies. On the abscissae are plotted the frequencies, and on the ordinates, the energy values or stimulus intensities.[1] The lower curve represents the minimum intensity of stimulus to which a subject will

[1] In the preceding sine curve representation of a sound wave (Figure 54), the area between the axis and the curve is considered the measure of the amplitude of energy of the stimulus. This may be mathematically determined as the *root mean square* of the area under the curve. The unit of measurement of force is the dyne. It is a force which, acting upon 1 gram for 1 second, will impart a velocity of 1 centimeter per second.

react. It will be seen that the greatest sensitivity is from approximately 1,000 cycles to 5,000 cycles, and decreases rapidly for lower and higher frequencies. It was also found that if the intensity were greatly increased, there was reached a limit at which auditory response was masked by other sensory processes, which limit represents the maximum intensity. This is shown by the upper curve. These curves represent the average results for several subjects. Where the two curves meet, we have the limits of audible frequencies.

Over the frequency band of 512-4,096 cycles, differential pitch sensitivity does not vary significantly; but from 512 to 64 cycles, this sensitivity diminishes at a rapid rate, as it likewise does from 4,096 cycles to the upper threshold for pitch. Although these minimal changes in the pitch-discrimination function are seldom recognized in ordinary biosocial behavior, it is interesting to realize that over the frequency band of 256-4,096 cycles, the levels most used in music, the differential pitch sensitivity of the ear is at a maximum.

**Analysis of speech sounds.** That speech is dependent upon the production of several vibration frequencies, which are relatively pure for the vowels and complex for the consonants, has been demonstrated by several investigators. D. C. Miller has perfected an instrument, the phonodeik, by which sound waves may be represented by an oscillating point of light and this oscillation photographed upon a film moving transversely to the oscillations of the point of light. The resulting curve is that usually employed to represent a sound wave. By means of the harmonic analyzer, this curve can then be analyzed into the constituent sine waves. Figure 57 illustrates the distribution of energy among the partials when the same vowel is intoned at various pitches.

Miller has shown that when a vowel is intoned, there is a wide range of frequencies which make up the quality of the voice, but the greater part of the energy is in those partials which fall within certain well-defined limits, no matter at what pitch of the voice the vowel is uttered. Some vowels are characterized by two regions of dominance of partials. Thus, the vowel *e* (as in m*ee*t) is represented by the partials approximating 300 cycles and 3,100 cycles, while *u* (as in m*oo*) is limited to the partials

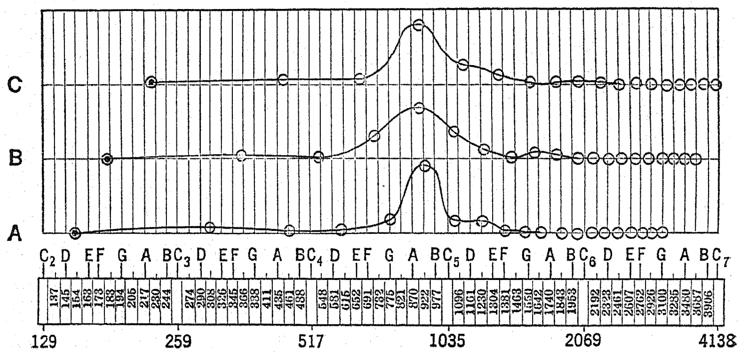


**Figure 57.—Distribution of energy among several partials of the vowel *a* (*father*) intoned at various pitches.** *A,* intoned at the pitch 155 *d. v.; B,* at 182 *d. v.; C,* at 227 *d. v.* (*Modified from Miller, "Science of Musical Sounds," p. 221, the Macmillan Company.*)

in the region of 300 cycles alone. The accompanying table gives the vowels and the corresponding frequencies as measured by Miller (Table IX).

These figures are not absolute, because the vowels are not spoken accurately. We approximate the correct sound and leave our listener to interpret it. It will be observed that there are a variety of sounds indicated by *a* which cannot be represented adequately in print. However, the chief point to be remembered is that each vowel possesses its own characteristic frequencies which do not vary with the pitch of the voice.

TABLE IX

REGIONS OF MAXIMUM FREQUENCY

| *Vowel* | *First Region* | *Second Region* |
|---|---|---|
| u (moo) | 326 | .... |
| o (mow) | 462 | .... |
| a (maw) | 732 | .... |
| a (ma) | 910 | .... |
| a (ma) | 1050 | .... |
| a (ma) | 950 | 1240 |
| a (mat) | 800 | 1840 |
| e (met) | 691 | 1953 |
| a (mate) | 488 | 2461 |
| e (meet) | 308 | 3100 |

When vowels are whispered, the voice sounds are practically absent and the larynx is relaxed. The result may be considered very nearly a pure vowel sound. Consonants may be considered in the class with noise: they possess some pitch, but it is not so important; they may be better expressed as hissing, explosive, and rolling sounds.

The sounds of speech that must be discriminated are rather limited, as compared with the absolute limits of pitch and loudness discrimination of which the normal human being is capable. This fact is illustrated by the shaded portions of Figure 56. When we remember that the upper and lower curves bound the area of auditory discrimination, as regards both loudness and pitch, we find that the requirements for the understanding of spoken language are not very great.

**Noise.** In the preceding sections, we have considered only those auditory discriminations that are classified under the head of "tone." Tones are produced by simple pendular vibrations or by combinations of vibrations that are in the simple ratios of 1:2:3 . . . . . , such as are

obtained from a vibrating string. If this complex of vibrations is not in such a harmonic ratio, we speak of the result as a *noise*. Thus, the scraping of the bow of the violin produces a noise which can be discriminated in addition to the tone because these vibrations have no simple ratio to each other. When a resined string attached to a tin can is drawn through the fingers, the resulting noise is due to the complex vibrations that have no simple relation.

Another factor in noise is the presence of beats that occur through the interference of the component vibrations. It is also found that if the stimulus of a pure tone is cut short, so that less than two double vibrations are allowed, the reaction is that of a sudden noise. This result may be due to the fact that the brief disturbance of the tympanic membrane has the effect of setting up a complex of vibrations, as would be the case with a complex stimulus of longer duration. This condition would be analogous to the action of a telephone receiver, the disc of which may vibrate to a continuous oscillating current in the form of a sine wave but, if the current is suddenly shut off or is intermittent, breaks up into complex vibrations that have no relation to the frequency of the electric current.

As a noise is usually the result of several vibration frequencies, one of which may dominate, it is to be expected that noises may possess some of the characteristics of tones. Some noises are high in pitch and others are low, corresponding to their dominant frequency. Noises may be discriminated in various ways. The boom of a big gun, the crack of a pistol, the whine of a bullet, the squeak of an ungreased bearing, and the roar of a waterfall express some of these characteristics. Evidently the difference between tone and noise is relative, depending

upon the complexity and the ratios of the component frequencies. Because of this greater complexity in the case of noise, our differential sensitivity in response to it is not so great as it is for tones, when the same standards of measurement are used.

## Auditory Space Discrimination

**Distance discrimination.** The auditory discrimination of distance is not nearly so accurate as the visual discrimination of distance. We may hear a noise and judge it to be far away or very near when the opposite is really true. Footsteps in the street and the sound of a whistle in the distance will be very inaccurately judged as to their distance. This is so partly because it has not been necessary for us to depend upon auditory cues, since we usually use our vision for the more accurate discriminations. Doubtless if we were unable to use vision, we would develop greater accuracy in our auditory discriminations. The fact that we do make auditory discriminations is dependent upon several factors.

In the first place, the intensity of a sound decreases as the square of the distance of the source from the listener. If, therefore, we know the character of the sound, we may judge how far away the source of the sound is by its relative intensity. Also, as most sounds are complex—that is, contain several partials—we may be guided in our determination of their distance by the character of the tone that we hear. Some of the partials will be weaker than the others as a result of the distance traversed by the sound.

**Discrimination of direction.** We can also localize, or determine the direction of, the sound source with a fair degree of accuracy, providing the vibrations are not re-

flected from other objects in the environment. We frequently hear echoes. Thus, if we are standing on one side of a building, the sound of an automobile horn on the opposite side of the building may seem to come from across the street because the vibrations travel around the building and across the street, and are reflected back from the buildings on the opposite side. Our ability to localize the direction of the sound source depends upon one of three factors and possibly on all of them.

(1) *Intensity difference.* It will be recognized that if the sound source is to one side of the individual, the sound should be more intense to the ear nearer this source than it is to the ear on the opposite side. Experiments have indicated that if the vibrations are led to each ear separately and the intensity shifted, the tone will be recognized as at the ear receiving the more intense stimulation. If the tone is complex, we would also have a difference in the character of the tone as it is heard at the two ears due to the shifting intensity relations between the various partials.

(2) *Temporal difference.* It will also be recognized that the tone should reach one ear sooner than it does the other if the source is to one side. The exact temporal difference can be calculated when we remember that vibrations travel approximately 1,100 feet per second in the air. Subtracting the difference in distance from the source of sound between the near ear and the far ear, we can determine how much sooner the sound reaches the one than it does the other. This advantage would apply to instantaneous sounds but would not apply so readily to continuous tones.

(3) *Binaural phase ratio.* The most difficult factor to understand and yet within certain ranges of frequency probably the most important factor is what we call the

*binaural phase ratio.* Let us consider a pure tone, which is one produced by a single harmonic vibration of the type described in Figure 54. We can see that if the vibration must travel farther to reach the more distant ear, the wave at that ear would be different from the one at the near ear. In other words, we may assume that the pressure against the near ear is at its maximum, represented by 90°. As the wave reaches the opposite ear a little later, the pressure would not quite have reached the maximum. In other words, it would be 90° minus a small quantity. So, throughout the period of stimulation, the one eardrum would be affected slightly earlier than the other. Any particular point in the curve represented in Figure 54 is known as a *phase.*

An experiment to demonstrate the effect of this phase difference may be performed in the laboratory with two tuning forks of nearly equal frequencies. One fork may have a vibration frequency of 256 cycles and the other one of 257 cycles. Naturally, if they are both vibrating at the same time, every second one will go through one more cycle than the other does. Let us assume that both start a condensation at the same instant. The one of higher frequency will gain on the one of lower frequency. It will have finished a condensation and have started a rarefaction before the other reaches the peak of condensation. In time, it will have gained sufficiently to be in the condensation phase (*B*, Figure 54) when the slower fork is in the rarefaction phase (*D*). As this continues, both will again be in the same phase.

We can see that, if the amplitudes of the two waves are equal, when they are in opposite phase, the condensation of the one wave should be neutralized by the rarefaction of the other, and no tone should be audible; and that when they are in the same phase, one should

reënforce the other and the tone should be louder. This is actually the case. In the example given, we hear a tone of rising and falling intensity once every second.

Now, if the two frequencies are led one to each ear, we hear, not a tone of varying intensity, but a tone that at first appears at one ear and then shifts to the other. It can be shown that this shift is determined by the phase relation between the two tones. When one wave is leading, the tone is localized on that side.

**Interpretations.** Numerous attempts have been made to explain these phenomena. It sometimes has been believed that the phase difference at the two ears resulted in an intensity difference, it being assumed that the vibrations were transmitted by bone conduction through the head from ear to ear. Recent investigations have proved in the case of individuals totally deaf in one ear that a vibration presented to the deaf ear cannot be heard even though this sound is sufficiently intense to be discriminated in the localization experiments with normal subjects. It seems probable that the temporal difference in the pressure at the two ears is directly discriminated as representative of direction.

It should be remembered that our ability to localize at all is dependent upon the fact that we have moved about and have seen the objects at the same time that we were stimulated through the ear. Just as in our visual discriminations we are dependent upon other senses in learning to discriminate, so in the case of audition we have learned to localize sounds because we have dealt in many other ways with the objects producing sounds.

### Questions for Review

1. List some of the situations in everyday life and some vocations which demand accurate auditory discriminations.

2. Give a brief description of the auditory stimulus. Upon what characteristics of the stimulus are discriminations of pitch, loudness, and quality dependent?

3. Why do a piano and a cornet sound differently even though each may be playing the same note? What does this fact indicate regarding the number of differently sounding musical instruments that could be devised?

4. According to Figure 56, does the frequency range most frequently used in speech lie within or outside of the frequencies included by the piano keyboard?

5. What are the reasons for the superiority of the modern victrola and radio over the earlier types?

6. How may noise best be described? Do noises have pitch? Are there individual differences in what will be considered a noise? What does this indicate regarding a definition of noise?

7. Are visual discriminations of distance and direction more or less accurate than auditory? Cite some examples in which this condition is reversed.

8. What are the important factors in auditory space discriminations?

### Reference

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## CHAPTER XXII

# Discriminations of Touch, Movement, and Equilibrium

Because the eye and the ear are such highly developed, special receptors, we are frequently led to believe that our visual and auditory discriminations are more important than our discriminations resulting from the more primitive receptors. It would be difficult to imagine, however, how we could get along in everyday life if we were entirely devoid of the ability to discriminate by means of the receptors in the skin. We would not be able to localize what part of the body was being stimulated when we came in contact with objects; we would not be able to gain important knowledge through manipulating objects which we see—an ability which we have already noted as an important part of our visual perceiving.

In a like manner, we can see how important it is that we can perceive the movement of the members of our own body. We have gained our visual perception of space very largely through the fact that we have been able to move—to reach out for objects or to walk to them. Our ability to stand upright as well as make many movements which require a change of position are dependent upon our ability to discriminate position. We maintain our balance or our equilibrium. These are all important discriminations without which our visual and auditory receptors would be of little value.

## Cutaneous Space Discriminations

**Tactual localization.** If the person is stimulated on his hands, face, or neck, he is able to tell in what general locality the stimulus has been applied, but he is unable to describe this touch in one area as different from that in another. It is the same touch or the same pressure except that it is in a different locality. This is very similar to what we found in visual space. We just seem to see the object out there visually and we simply "feel" the stimulations on the skin as being on the cheek, hand, and so on.

Experiments have shown that we are able to localize a touch on the skin more accurately in some areas than in others. If a pointed brass rod is brought into contact with the fingers of his left hand, the subject can, with eyes closed, indicate the specific area by touching it with a pencil point with an error of only one or two millimeters. If the area stimulated is on the back of the hand, he will still be fairly accurate, but is likely to make an error of five or six millimeters. On the forearm, his error will be as much as from 10 to 15 millimeters. On other areas of the body, we find similar variations in accuracy of localization.

The individual, in other words, exhibits some degree of accuracy in localizing contact on the skin, and this accuracy is greatest on those parts which are most mobile. Thus, we find that as we progress from the upper arm to the lower arm, the hand, and the tips of the fingers, he becomes more and more accurate.

**Two-point threshold.** If two points are stimulated simultaneously, they may be recognized not as two points, but as one. As the points are more widely sepa-

rated, a distance may be determined at which they will be just noticed as two. To determine this two-point threshold on a given area, an instrument similar to the one illustrated in Figure 58 is generally used. If we start with the two points near enough together so that they are judged as one, we continue increasing the distance between them until they are judged as two, then take the reading, and move the points far enough apart so that they are easily discriminated as two points when they touch the skin. The distance is then repeatedly decreased until the subject reports one point.

After this experiment has been repeated several times, the mean of all the readings is determined and is considered to represent the two-point threshold. This threshold will be greater on the back of the neck in the longitudinal direction than it is in the transverse, but it is much greater in either direction there than on the forearm. Again, it is still less on the hand and the tip of the finger.

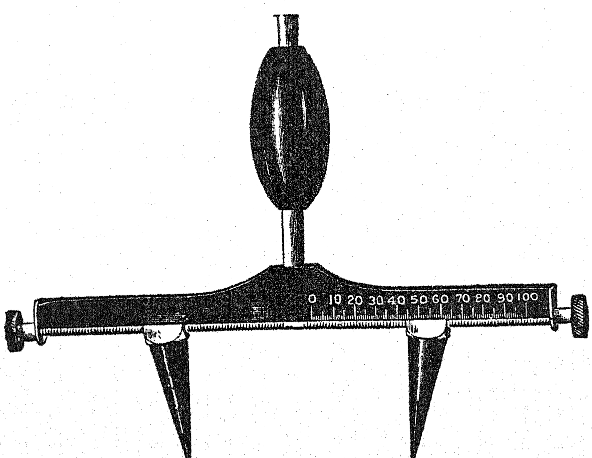


**Figure 58.—Double Esthesiometer for the Determination of the Two-Point Threshold.** (*C. H. Stoelting Co.*)

**Explanation of cutaneous discrimination.** It may be shown,[1] however, how this localization has been learned through the reactions the subject makes to stimulation. To take an example, let us suppose a starfish is stimulated on one arm. All the arms will respond, but only the response of the one directly stimulated will directly affect the stimulus. Its movement will either increase or decrease the stimulus. In time the other arms will cease to react when this arm is stimulated. The stimulus, we say, therefore, is localized in this arm. With further stimulation of one area on this arm, the response will become more limited to this area. The starfish will respond differently when this area is stimulated than when some other area on the same arm is stimulated.

The same principle applies to human learning of localization. The accuracy of localizing is directly related to the degree of mobility of the part stimulated. The error of localization and the two-point threshold are greatest on the trunk, less on the arm, and least of all on the tips of the fingers. Furthermore, the accuracy is greater in the transverse than in the longitudinal direction on the forearm, and we can more easily rotate the arm than we can move it forward and backward.

**Localization in children and the blind.** The significance of the argument that localization is a function of learning is more forcefully exemplified by a comparison of the results with children and with adults in tactual localization. If such discriminations are due to training, we might naïvely expect that error in localizing would be greater with children than with adults. Experiments have demonstrated[2] the reverse to be true, as is shown in

[1] Peterson, Joseph, "Local Signs as Orientation Tendencies," *Psych. Rev.*, 1926, Vol. XXXIII, pp. 218–236.

[2] Renshaw, S., "The Errors of Cutaneous Localization and the Effect of Practice on the Localizing Movement in Children and Adults," *Jour. Genet. Psych.*, 1930, Vol. XXXVIII, pp. 223–238.

Figure 59. It will be seen that the adults are considerably more inaccurate than the children; and that the adults are less accurate in localizing on the arm than on the hand, while the children exhibit very little difference in these two areas.

The explanation for this apparent paradox is to be found in the fact that the children are learning to localize *tactually* while the adults have passed this stage and have learned to substitute visual cues. The investigators tested this hypothesis in this way: In one group of tests, the subjects, with eyes closed, attempted to touch the spot stimulated. In an alternate test, they were allowed to open their eyes immediately after the stimulation and then to attempt to locate it.

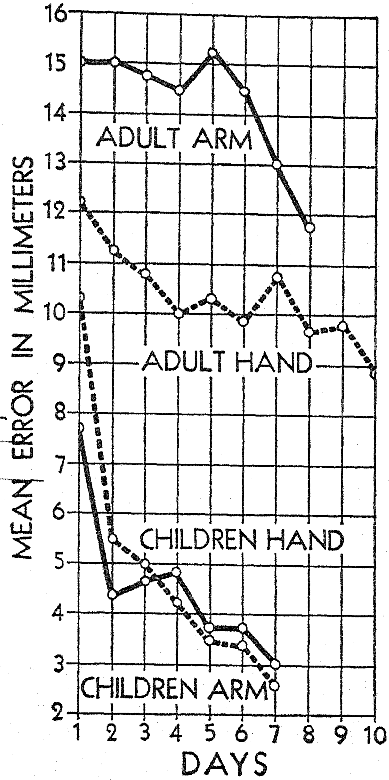


**Figure 59.—Mean Daily Errors of Localization on the Hand and Forearm by Adults and Children.** (*After Renshaw.*)

The average error for the children under the first condition was 7.9 millimeters, and under the second, 9.41 millimeters.

In other words, the children were more inaccurate in

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Renshaw, S., Wherry, R. J., and Newlin, J. C., "Cutaneous Localization in Congenitally Blind *vs.* Seeing Children and Adults," *Jour. Genet. Psych.*, 1930, Vol. XXXVIII, pp. 239–248.

localizing when they could see the area just stimulated. The corresponding results for the adults were 10.37 millimeters with eyes closed and 6.16 millimeters with eyes open. The adults' visual cues were a decided advantage.

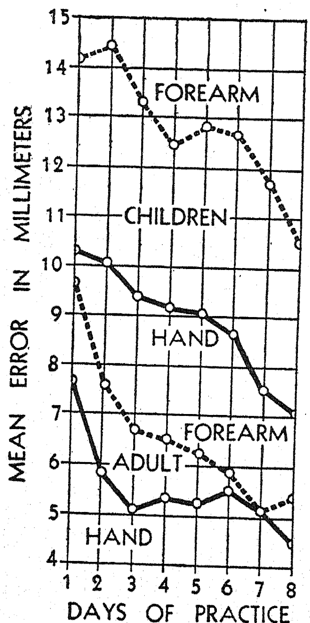

**Figure 60.—Mean Daily Errors of Localization by Blind Adults and Blind Children.** (*After Renshaw, Wherry, and Newlin.*)

This fact of substitution of visual cues is further demonstrated by the comparison of the errors of blind adults and children. Figure 60 shows that the errors of blind adults are less than those of blind children. The adults have continued to improve in purely tactual localization because they could not substitute vision.

## Discriminations of Movement

Discriminations of movement cannot be attributed to a single class of receptors, but are really dependent upon receptors located in several positions of the member that is moved. When we move the arm, for example, the skin about the joint is bent, stimulating cutaneous receptors. There are also receptors in the muscle and tendon which are stimulated by the pressure produced by the strain upon the muscle or tendon. There are also some receptors apparently on the surface of the joint which may be stimulated as the two surfaces rub together in movement.

If, for example, the skin is anesthetized and pressure

applied over a muscle or tendon, a response is elicited which is termed the *deep pressure sense*. It is possible to perform a laboratory experiment which indicates the relative importance of these receptors in the skin, joint, tendon, and muscle. The arm of the subject is placed upon a tilting board with the elbow at the stationary end of the board. If the movable end of the board is raised very gently, the arm is moved passively. The subject is to report when he realizes that the arm is being moved. In this way it can be determined how far the arm can be moved passively before the subject discriminates the movement.

If, now, the skin about the elbows is anesthetized by spraying with ether, which chills the receptors, and the arm is again moved, it will be found that greater movement is necessary before the subject reports any movement at all. In the third test, a weak induction current is sent through the elbow joint, anesthetizing the receptors in the joint surface. The same procedure may be used with the tendon and with the muscle. The results indicate that the receptors in the muscle and tendon are most important in discrimination of movement of this kind, but that the receptors in the skin and joint also contribute.

The importance of the kinesthetic sense, or deep sensibility, cannot be too greatly stressed. The muscles are always in a state of partial contraction, and hence these end organs are constantly stimulated. Bodily posture and the tonic condition of the muscles, as well as the movements made in response to efferent impulses, are due in large part to the impulses sent in by these systems. In fact, it would be impossible to conceive of the behavior of a person in whom these impulses did not exist. Though its organs are not so highly developed as the

sense organs for vision and audition, the kinesthetic sense is of fundamental importance for behavior.

## Equilibrium

In addition, from the end organs in the muscles and tendons, the afferent impulses of which control movements and the tonicity of the skeletal muscles and thus are responsible in large measure for our ability to stand or walk or maintain any normal position, there are also special mechanisms in the inner ear which are closely associated with the same functions (Figure 16, page 89). Because of their proximity to the cochlea, it was formerly assumed that they, too, were end organs of hearing, but this assumption has been generally abandoned. That these mechanisms are important in the maintenance of equilibrium and help to maintain our control of movement is easily demonstrated. Every small boy has amused himself by turning around several times and then standing still to see the room go round. We shall see, however, that though these organs do function in maintaining balance, they are not the only means of such control.

**Balance mechanisms.** Close to the cochlea and continuous with it are three *semicircular canals* and two sacs, the *sacculus* and *utriculus*. They form a continuous labyrinth in the cavities of the skull. The three semicircular canals are situated at right angles to each other, two being vertical and one horizontal. The two vertical canals each make an angle of 45° with the median plane of the head. By this arrangement the anterior canal of one side and the posterior canal of the other side of the head fall in parallel planes.

There is an enlargement, the *ampulla,* of each canal

near its junction with the utriculus. Within the ampulla are the *cristae,* or supporting cells, which contain long, cylindrical hair cells, the hair processes extending into the endolymph. The sacculus and utriculus contain hair cells and supporting cells forming the *macula.* Lying among the hairs in the macula are small crystals of calcium carbonate.

**Experiments in rotation.** If the subject is seated in a rotating chair with eyes closed and with the instructions that he is to report regularly the direction in which he is rotated, he will report correctly as the chair is accelerating; but as soon as the speed of rotation becomes uniform, he will report that the rotation is slowing down or has actually stopped. As the speed of rotation is decreased, he will report that he is being rotated in the opposite direction. Two facts are to be noted. If the speed of rotation is perfectly constant, the subject does not appreciate that he is being rotated. It is only during the periods of acceleration or deceleration that the subject reports movement. Evidently, to the extent that the semicircular canals function in this experiment, they are effective only at the times when the speed is changed and a disturbance caused in the hair cells. These cells apparently become quickly adapted to their changed position when the movement becomes constant.

**Nystagmus.** A typical optical reflex may also be demonstrated as a result of rotation. If the subject is rotated several times with his eyes closed and then is suddenly stopped and opens his eyes, it will be observed that his eyes make slow movements in the direction of the previous rotation and quick jerks back to the original position. This is called *post-rotational nystagmus.*[3]

[3] Valentine, W. L., "Responses to Rotation and Translation," a movie film prepared at the Ohio State University.

The explanation of these phenomena is that the endolymph in the horizontal canals during the acceleration of rotation lags sufficiently to press against the hairs of the cristae; but when rotation is completely stopped, this fluid, by reason of its inertia, again presses against the hairs in the opposite direction. As a result of this stimulation, the eyes are stimulated to movement as they would be if the individual were turning. Consequently, the objects at which he looks seem to be moving in the opposite direction and he makes quick readjustments or pursuit movements to keep up with the apparently moving objects. For this reason, when the small boy has been whirling in a swing, everything seems to be swimming about him. Really, the reverse stimulation of that to which he is accustomed is taking place. In other words, the stimulation of the semicircular canals has assumed dominance over the usual visual field.

**"Falling" experiment.** Similar experiments affecting the other canals may be performed. For example, if the subject leans forward until the vertical canals are in a horizontal position, and then, after rapid rotation, sits up quickly without opening his eyes, he will fall in the direction in which he has been rotated, though he will report that he was falling in the opposite direction. The explanation of this phenomenon is the same as that of the nystagmus: the violent stimulation of the vertical semicircular canals produces the effect of falling in the one direction, and the subject's attempt to sit upright throws him in the opposite direction.

These experiments indicate that the semicircular canals function through the movement of the head to stimulate muscular responses that maintain the coördinations involved in equilibrium. In addition, it is supposed that

the otoliths in the sacculus and utriculus press upon the hairs when the head is in the upright position and thus function in static equilibrium.

There is a quick adaptation to these stimuli if they are continued long enough. Acrobats and dancers do not become "dizzy" as a result of being rotated.

**Other cues to equilibrium.** That in equilibrium we use other cues, such as vision and the stimulation of receptors in the muscles and tendons, is quite evident. In experiments that have been performed upon pigeons, part or all of the semicircular canals were removed. At first the pigeons walked in circles and had difficulty in standing or eating, but ultimately they could not be distinguished from normal pigeons. This return to normal behavior is attributed to the establishment of visual or kinesthetic cues as substitutes for the labyrinthine stimulation. One pigeon was observed to behave normally a few days after the operation so long as he remained in a small cage; but when placed on the floor, he showed all signs of the disturbance. When the cage was set over him, he promptly stood up and walked normally until the cage was again removed. This act indicated that the visual cues of the cage were necessary at this stage in his recovery.

In many cases, individuals suffer from an infection in the inner ear. The infection destroys not only the auditory mechanism but the semicircular canals. Though they are hopelessly and totally deaf, they suffer no great permanent inconvenience because of the loss of the semicircular canals. They evidently learn to depend upon the muscular cues. During the War, it was assumed that aviators could not fly if the semicircular canals were defective. This was because it was believed that in the

air the individual lacked the normal support of the other senses that he has on the ground, and that he must depend only on the so-called "sense of equilibrium." This belief is not entirely accurate. A pilot sits upon a seat, resting against the back, and he is usually protected by a wide belt about his waist. The pull of gravity will give him many cues that we call "tactual" and "deep pressure" which will indicate to him whether his plane is upright even though he cannot see the ground. There were numerous reports that pilots who flew through a dense cloud would come out to find their plane bottom side up. If these stories were true, one can only infer that the pilot was so greatly disorganized that he did not appreciate the cues presented through the fact that he was sagging against the belt, blood was rushing to his head, and the pressure on the seat was eliminated.

**Summary.** In reviewing our description of sensory discriminations, we may conclude that though we possess two highly developed receptors in the eye and the ear, the most important fact concerning discriminations is that in all of them the functions of the various receptors are very closely interrelated. Our visual discrimination of space is dependent upon what we have learned through tactual and kinesthetic receptors. The same is true with regard to our auditory discriminations. On the other hand, because we possess these highly developed tactual and kinesthetic receptors, we are also very largely dependent upon them in learning to discriminate. Even though the semicircular canals are important in our discrimination of position and movement, these stimulations are intimately bound up with visual, tactual, pressure, and kinesthetic processes. It is only in unusual laboratory situations that any one receptor mechanism plays a dominant rôle.

## Questions for Review

1. What is the evidence which indicates that tactual localization is a form of learning?

2. Why are blind people able to make much finer tactual and auditory discriminations than seeing individuals?

3. Are there other sense modalities in which visual cues are substituted for those which come directly through a specific type of receptor?

4. Compare the levels at which the error curves occur in Figures 59 and 60. What does this comparison indicate regarding tactual localization in these subjects?

5. List the various sense modalities that are involved in most of our discriminations of movement. Give an example of each in which it plays the more important rôle.

6. Why should the results of experiments performed on blindfolded, seeing subjects not be applied in work with blind people?

7. List some everyday experiences in which sensory discriminations are made in response to stimulation through only one sense modality. Are such discriminations made relatively frequently or infrequently?

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# SECTION VIII. HUMAN AND ANIMAL LEARNING

## XXIII. The Principles of Learning
## XXIV. Economy in Learning

References to Student's Guide:

Exercise 58. Maze Learning in Human Subjects
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## CHAPTER XXIII

# The Principles of Learning

**Introduction.** How one acquires new modes of adjustment or alters his behavior to meet more efficiently the demands of his physical or social environment has been of interest to us throughout this volume. At birth the infant possesses few, if any, thoroughly integrated modes of response. What responses he possesses are quickly modified and become more effective as he comes in contact with his ever-changing environment. The child *learns* to avoid certain noxious stimuli, he *acquires* more definite food-getting habits, and he *learns* that certain sounds are an indication of preparation for his comfort.

Emotion, attention, and perception are phases of behavior that depend upon what the individual has learned. One may have developed a habit of reacting emotionally to certain situations while another has learned to react in a perfectly organized manner to a situation that at an earlier date was completely disorganizing. Phobias, such as fear of closed places or of running water, and the milder forms of likes and dislikes are examples of the former. The raw recruit in a battle or on the football gridiron is more likely to "lose his head" than the experienced soldier or player. Again, what we observe or how accurately we discriminate is dependent upon training in some specific field, as well as upon the sense organs involved.

**Criterion of learning a social standard.** We usually say that an act is learned when an individual can accomplish a certain performance. Thus, a poem is learned when it can be recited correctly without prompting. This does not mean, however, that the individual will react in exactly the same way every time he recites the poem. Sometimes he recites it from a platform to a large audience. At another time he repeats the poem silently in his own room. There may be a great many variations in the performance, but just so long as he recites the poem, we say that it has been learned.

We may also learn to perform a certain task correctly and find, with numerous repetitions, that we vary our method of performance from time to time, and that the task may incidentally become easier to perform. We may be able to recall a certain event which occurred several years ago. We do not necessarily behave in recall as we did at the time the event first occurred; our behavior in recall varies with the circumstances. For these reasons, we look upon learning as a criterion set up without reference to what is actually going on in the organism. It merely refers to a fact based on a certain standard which is set by the observer—the task can be performed and is therefore learned.

**Learning, memory, and habit.** In view of the fact that learning is so universally important, it is essential that we analyze rather carefully what is known regarding the nature and laws of the learning process. Some of the problems which should be considered are the following: (1) What factors are involved in establishing a new performance? (2) Why does repetition of an act result in learning; that is, what is taking place during successive performances of an act that results in the final successful act? (3) What are the best methods of acquiring skill

or of memorizing poem or prose selections? (4) Are there distinct types of learning, such as motor learning, ideational learning, trial and error learning, and learning by insight? (5) What are the distinctions between animal and human learning? (6) Can the ability to learn be improved? (7) What is the relation of the nervous system to learning; that is, is there some modification of nervous tissue or a definite establishment of nerve patterns which function in conformity to the new performance?

It will not be possible to give a precise answer to each of these questions. While some of them can be answered very definitely, others present themselves merely as questions for which we should seek an answer in further investigations.

**Learning and memory.** The fact that we have experienced a certain event and at a later time can report the same event quite accurately leads us to say that we have "remembered" the event. *Memory* is a general term for the fact that we have dealt with the situation and somehow are able to report the event sufficiently well so that this report is considered symbolic of the fact that the experience is retained. Usually, we use the term *learning* to refer to the fact that the earlier experience has somehow modified our behavior. Both terms, therefore, refer to the same process: in the first place, the individual must have reacted to the situation or made a certain investment in activity; second, this investment must have a more or less permanent effect upon the individual; and third, he must be able to reproduce or recall wholly or in part the previous experience.

If you remember the conjugation of a verb in Latin, it is because in high school you made a certain investment in responding repeatedly to the conjugation situation.

The work done then has had a persistent effect which is evidenced by the fact that a suggestion or a stimulus word now may result in a recall of the verb form which you are certain is correct because you learned it in school. The present situation is totally different from that of the learning situation, and your response is totally different from your response to the original situation with the exception that you are able to repeat the verb form required. You may have learned to use the typewriter but have had no occasion to do any typing for several years. You now sit down to the typewriter and find that you can type apparently as readily as when you last used the typewriter. You will recognize that your performance is more nearly a reproduction of the original performance than the recall of a Latin verb. Neither performance is an exact reproduction. In general, a recall of a part of a situation which is indicative of the whole we call *memory*. The more complete reproduction of skills we call *habit*. Both of these words are descriptive. They are not explanations of behavior. It would be incorrect to say that we recall a Latin verb form or operate the typewriter from "force of habit."

**Animal and human learning.** Just as we have indicated that there are not two kinds of learning—motor learning and mental learning—but only differences in the complexity of the processes involved, we shall be able to show that the differences between the lower animals and man are differences in the complexity of the problems solved or in the number of explicit movements involved. A man may examine a puzzle, for example, and note the correct solution without any outward signs of activity, while the cat would make many easily observed movements, such as scratching, fighting, and turning, and finally hit upon the correct act accidentally. In later

trials, both shorten the time necessary for the solution, the man much more rapidly than the cat. The fact that we cannot observe the tentative and implicit movements of the puzzle solver does not make the solution of the puzzle less accidental.

### Experimental Studies of Animal Learning

As psychologists, we are interested in learning in the lower animals for two reasons. First, our interest in human behavior arouses an interest in what goes on in animals lower than man. We are curious to know how such an animal gets along in his world. Also, the principle of evolution leads us to inquire how far down in the animal series we shall find learning and to what extent it resembles learning in man. This naturally leads to the second point of interest. If we can find that the lower animals display only a more primitive form of human learning, then we should be able to establish certain laws of human learning by experiments with animals that would be difficult or impossible with human subjects.

The scientist who is working on some baffling disease or a new serum performs his first experiments upon guinea pigs and rabbits. If he is particularly cautious, he may later use monkeys and higher apes before he ventures to apply his discovery to man. In psychological investigation it is often difficult to carry out an experiment with human subjects with the proper control. The human subject either knows something about the problem or possesses an attitude toward the experiment that may vitiate the results.

In all learning experiments it is very important to know what has happened to the subject in between the formal practice periods. Loss of sleep, indigestion, and bad

news from home affect the human subjects' learning scores; but, obviously, better control can be obtained with laboratory animals. It is also impossible to perform on human subjects experiments which involve the destruction of tissue. It would hardly be possible to have human subjects meet some criterion in a learning problem and then to extirpate portions of their brains to observe whatever effects might follow, as has been done with rats.

**Learning in the simplest animal forms.** Numerous attempts to demonstrate the possibility of learning in the single-celled animals have been made. Experiments[1] with the amoeba lead to the conclusion that it gives evidence of learning analogous to that in the higher forms. Amoeba is negatively phototropic; that is, it reacts by turning away from light. In these experiments, a beam of light was repeatedly directed across the path of the moving amoeba. The amoeba generally withdrew a short distance and then came ahead again in the same direction. The number of times it entered the beam before finally changing the direction of its course was recorded. The experiment was repeated 27 times with each of 5 animals. It was found that the number of times necessary was, on the average, reduced at such a rate as to suggest learning. The effects of this learning did not wholly disappear even after two days.

A similar experiment with paramecium has also been interpreted as evidence of learning. A drop of water containing one paramecium was introduced into a fine capillary tube with a diameter somewhat less than the length of the animal. When the paramecium swam to the surface film at either end of the drop of water, he would exhibit the usual reversing movements, but in this

[1] Mast, S. O., and Pusch, L. C., "Modification of Response in Amoeba," *Biol. Bul.*, 1924, Vol. XLVI, p. 55.

case the body had to be bent. The time required to execute this reversing process was gradually reduced.

In these and similar experiments there arises the question as to whether this is evidence of true learning or of physiological adaptation. The amoebae were kept under low illumination except for the intermittent beam of light, and, hence, may have become dark-adapted, in which case the effectiveness of the light stimulus would have increased. Owing to the limited volume of water in the tube, the paramecium may have shrunk because of the loss of oxygen, and, hence, the bending was more easily executed. In general, little credence is given to the evidence of true learning among the protozoa and the coelenterates. ?

**Learning in the earthworm.** The modification of the behavior of the earthworm appears more definitely to be modification to which we would ascribe the term *learning*. The earthworm was inserted in the main alley of a T-shaped maze. If it turned to the right, it would return by this route to the burrow. If it turned to the left, it would first pass over sandpaper and, shortly beyond this, would receive an electric shock. In the first trials, the earthworm turned left as often as right; but after 1,000 trials, it turned always to the right.[2] Only one earthworm completed the experiment.

**Criterion of learning.** It is generally held that real learning occurs only in those animals that possess a central nervous system. The earthworm is an example of a comparatively simple organism that possesses a central nervous system which permits of the establishment of connections between different structures. The response of turning to the right leads to the response of entering

[2] Yerkes, R. M., "The Intelligence of Earthworms," *Jour. An. Behav.*, 1912, Vol. II, p. 332.

the burrow, while turning to the left leads to scratching sandpaper and electric shock. At first, all of these stimuli are included in the situation; but with repetition, scratching stimulation leads to reversal and smooth stimulation to continued movement toward the burrow. Real learning is assumed to occur when a part of the former stimulating situation becomes the stimulus for the reaction. This phenomenon is frequently termed "associative memory" as distinguished from adaptation.

**Experiments with fish.** Several minnows of a species which avoids bright light were placed in a tank so constructed as to form a maze.[3] One end of the tank was darkened, and the minnows were fed at this end. For the experiment, one minnow would be confined in the light end of the tank and glass partitions which had holes in them were placed at different distances from the ends. The fish first would swim up and down the length of the partition, frequently bumping against it. Eventually it would come to the opening and swim through. Upon being repeatedly returned to the light end, it indicated it had profited by the previous experiences; that is, it swam more directly for the openings.

**Retention in fish.** An interesting experiment shows the formation and the retention of a habit in perch. They were fed upon live minnows in a tank for several months. At the beginning of the experiment, a glass partition was inserted between the minnows and the perch. The test continued for 30 minutes each day. At first, the perch would dart against the glass in an effort to strike at the minnows. On succeeding days, their efforts were less violent, until finally they avoided striking even when the minnows came near the partition.

[3] Thorndike, E. L., "Animal Intelligence, an Experimental Study of Associative Processes," *Psych. Rev. Mono. Sup.*, 1898, Vol. II, No. 41.

When the glass was removed, the perch remained in that portion of the tank in which they were originally confined. When they approached the original position of the partition, they turned to one side. Ten days after the partition was removed, they still swam out to the mark and then turned and swam back. It was proved conclusively that the fish had learned to avoid the obstructing partition, and had thereby learned to desist from attempts to secure the minnows. This learned response persisted for several days after the partition was removed.

This experiment is particularly interesting because it is known that game fish will strike within thirty minutes after they have been hooked and broken the line. Evidently, the single experience of being hooked is not so effective as repeated experiences in the tank experiment.

**Experiments with chicks.** In a simple maze,[4] from which the young chick must escape to food and to the rest of the brood, the behavior of the chick resembles that of the fish. When the chick is placed at *A* (Figure 61), he runs back and forth, in and out of the blind alleys,

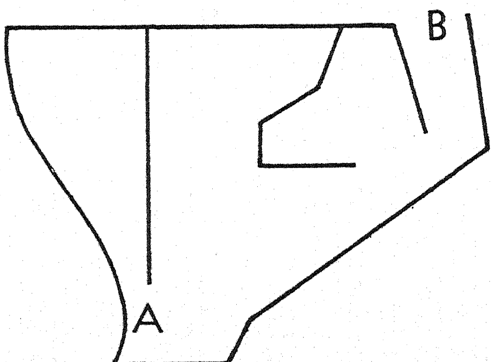


Figure 61.—Thorndike's Maze for Chicks.

[4] Thorndike, E. L., *op. cit.*

and tries to jump over the walls. Finally, he hits upon the correct path, which leads to *B*, the place of food and of the other chicks. Put back again at *A*, his behavior is much the same as before; but soon he begins to eliminate the "useless" movements, and finally he can run directly to the exit.

**Maturation and learning in chicks.** Another experiment which was performed with chicks for another purpose gives interesting results on the relation of age and practice in the learning of young chicks. It is generally assumed that the chick pecks accurately at food particles as soon as it is hatched. A brood of chicks was kept in a dark room and fed soft meal, which was placed in their bills.[5] Each day some of the chicks were taken out and allowed to peck at small grains. The number of successful hits out of 50 trials was recorded. Figure 62 illustrates the results.

Curve *S* represents the improvement of the group of chicks living under natural conditions. It will be seen that they were 20 per cent accurate on the second day, the first day of food, and improved gradually thereafter until about the tenth or eleventh day. Group I was given the first exposure to grain on the fourth day, Group IV on the fifth, and Group V on the sixth. The later groups started with approximately the same low percentage, but improved more rapidly than the earlier groups.

These results suggest two important conclusions: (first, that pecking, or food getting, is dependent very largely upon training; and second, that age or growth is also an important factor.) The older chicks which had not been allowed to see the grains and to peck started at approximately the same low level of accuracy as did the chicks

[5] Shepard, J. F., and Breed, F. S., "Maturation and Use in the Development of an Instinct," *Jour. An. Behav.*, 1913, Vol. III, pp. 274–285.

under normal conditions; but the older chicks improved more rapidly.

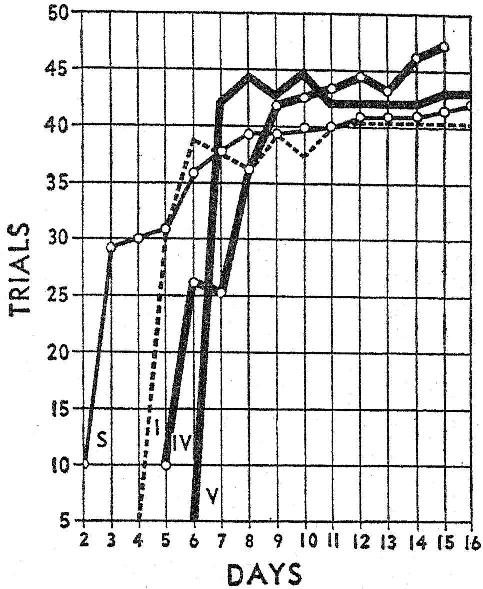


**Figure 62.—Curves Showing Improvement in the Pecking of Chicks.** (*Modified from Shepard and Breed, p. 278.*)

**Interference with normal learning.** More recently, this experiment has been repeated in the same laboratory. (The chicks in this case were kept in the dark room and artificially fed for 14 days. At the end of this period they were brought into the light and surrounded by small grains. They made no attempt to peck at the food, and most of them actually starved to death.)

It would appear that two factors have influenced the thwarting of the normal pecking response. First, the normal stimulus had been absent for so long a time that the normal response had no opportunity to develop. A second and equally important factor is the fact that there

have been developing other modes of response which are substituted for pecking. Hunger has been satisfied by hand feeding instead of by pecking. It is not merely the dying out of the pecking response; it is also the establishment of other habits somewhat analogous to those of the man who goes hungry because his cook has left.

The maze. Numerous forms of the maze, or labyrinth, have been used with many types of animals. Figure 63 illustrates one form of the maze. Posts, grooved on four sides, are set up in the floor or base, and panels are inserted to make a maze of any form or difficulty. The

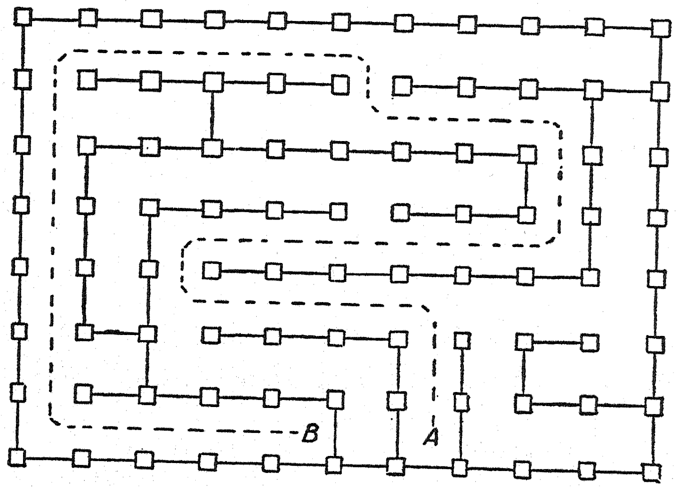


**Figure 63.—One form of maze.** $A$ is the starting point and $B$ the food box. The line indicates the correct path. (*Modified from the J. F. Shepard maze.*)

walls must be sufficiently high so that the animal cannot jump over, or else should be covered with glass or wire screen. The surrounding walls of the room are generally uniform, and the light is so distributed that all parts of the maze are of equal brightness. The animal should be

observed from a platform obscured from his view. The prevention of all possible distractions and outside cues is important in all such experiments, though it was frequently neglected in the earlier investigations.[6]

In maze studies, one may record the time required to reach the food box, the number of errors—such as entering blind alleys and retracing—and the total distance run before the food box is reached. In the maze shown, the distance can be determined in terms of the units of which the maze is constructed. Figure 64 shows a representative curve of learning based upon time required in each trial to reach the food box.

**Behavior the basis of learning.** The question as to what guides the rat or other animal when he learns to run directly along the true path to the food box arises. We have eliminated outside cues or stimuli, such as windows or doors in the walls of the room, the position of

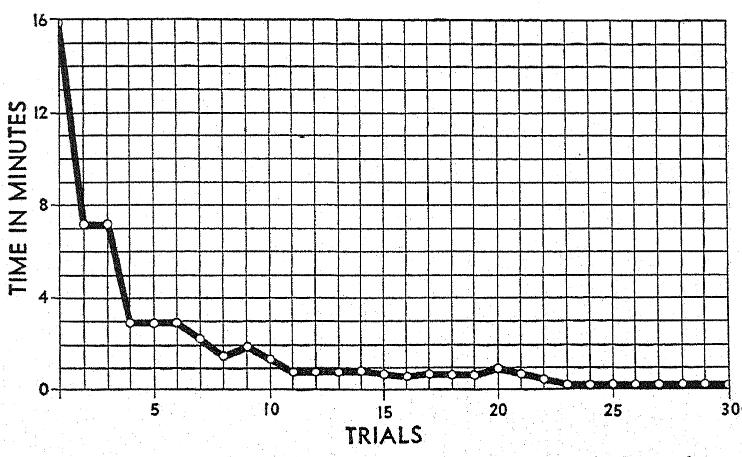


**Figure 64.—A Curve of the Average Time of 19 Rats in Learning a Maze.** (*Watson.*)

[6] Ford, Adelbert, "Maze Learning in White Rats," a movie film prepared at the University of Michigan.

the experimenter, and the position of lights or shadows. There remain possible variations in the walls and floor of the maze, olfactory cues from the food box, animal tracks on the floor, auditory differences as the rat patters along the alley, and kinesthetic cues from the rat's own movements. Each of these possibilities in turn has been eliminated. (The conclusion reached is that kinesthesis is the important factor.)

### Brain Extirpation Experiments with Animals

The notion that the nervous system is necessary in the phylogenetic scale before there can be any real evidence of learning (page 351) is an example of a scientific conclusion which finds general agreement in popular opinion. Actual removal of parts of the brain of a living animal and a subsequent examination of the learning efficiency produces a scientific result which contradicts in many respects the popular impression of what is likely to happen.

Popularly, the brain of a child is frequently considered a kind of impressionable unit somewhat analogous to a blank tablet of soft wax upon which an experience leaves a trace. Some of these traces are figuratively deep, and others, at least at first, are mere scratches. As a matter of fact, this notion of a figurative trace is identified in the thought of some people with the wrinkled appearance of the cerebral cortex. This crude notion is, of course, absurd. It is not absurd to attempt to locate the specific place in the brain that is necessary for the execution of a habit once learned. This was the problem that an investigator (Lashley) set for himself.

**Visual discrimination habit.** Nerve fibers from the eyes, after a series of complicated connections, eventually reach the occipital lobe of the brain. Any habit involv-

ing a brightness discrimination should thus be interfered with if the cortex of the occipital lobe were destroyed. Experiments with white rats proved this to be a fact.

Control experiments in which various parts other than the occipital portion of the cortex were invaded were made. Here the results were negative: there was no influence on the visual discrimination habit. (These results made it appear that the visual area in the brain is a necessary part of the equipment of an animal which would make visual discriminations.) Whether traces are gross anatomical features of the brain or less stable physiological relationships is not answered by this experiment.

**Relearning with the visual area destroyed.** In an extension of the experiment, the animals were retrained on the problem in order to find out whether they would ever be able to learn anew with the visual areas destroyed. *They did learn again.* The number of trials was not greater than the number required to learn the habit in the beginning, even though as much as a third of the *total* area of the cortex was missing. There was no observable difference between animals that were first operated and then trained and normal animals with the brain intact.

(We must conclude, then, that if a discrimination habit is once learned, there is a necessary locus of brain tissue; but for habits that are being learned, one part of the brain functions as well as another.) If the important locus is destroyed, other tissues function for the missing parts as effective substitutes. From these data we may infer that, in learning, the cortex does not function as a precisely wired electrical mechanism nor as a wax plate upon which impressions have been made.

**The maze habit.** For mazes, where the whole learning situation is presumably more complex, experiment shows that no part of the cortex is more important than

any other. In this respect maze learning is different from simple sensory discrimination. When a part of the cortex is destroyed, there is an impairment in performance, but it is proportional to the *extent* of the lesion, not to the specific area. This is an important finding because, historically, the frontal lobes of the brain have been considered the seat of the higher intellectual processes. Although a white rat's performance in a simple maze may not be considered an intellectual performance *par excellence,* nevertheless we should expect, if the hypothesis were at all true, that there would be more impairment in this function as a result of frontal-lobe destruction than of destruction of the other brain fields known to be concerned in vision, hearing, smelling, and so forth. The truth of the hypothesis is further negated in another experiment [7] in which problem solving of a more complex type was involved and again the specific area in the brain was found to be unimportant whereas the amount of destruction was roughly proportional to the observed ability of the animals.

## Human Maze Learning

One of the problems in human maze investigation has been to make the task comparable with animal maze learning. This presents two important difficulties. First, the alley of the maze should be as uniform in appearance as the animal maze and should be run in the same way. This is practically impossible because of the size of the maze necessary, which makes the expense prohibitive. Walking through a maze blindfolded and tracing a maze

[7] Maier, N. R. F., "The Effect of Cortical Destruction on Reasoning and Learning in Rats," *Jour. Compar. Neurol.,* 1932, Vol. XLIII, pp. 45–75 and 179–214.

screened from view are quite different situations. In the second place, the motivation is not the same. Usually, the animal is hungry when placed in the maze for the first time, but has no notion why he is placed as he is. The human subject has to be told that he is to find the end. (He usually starts out with the intention of memorizing the correct path.)

A number of types of mazes have been constructed for the purpose of investigation with human subjects. In some cases, the maze is constructed exactly like the animal maze except that it is enlarged so that the subject can walk through the alleys as the rat or other animal does. This is unsatisfactory because it is so difficult to make the walls so uniform in appearance that the human subject does not get visual cues. To obviate this difficulty, the maze is cut in a sheet of metal, and the subject, blindfolded, traces the maze with a stylus. An improvement over this type is the so-called "high relief" maze[8] (Figure 65). This is constructed with short strips of wire, which are bent into long, square staples of suitable lengths and driven into a wooden panel in the desired form of the maze. The blindfolded subject traces this maze with his finger. This has the advantage over the slot maze in that the subject gets a more intimate contact with the maze and is not in danger of passing an alley without being aware of it.

There has been devised an apparatus in which only the turns of the alleys are preserved.[9] These are represented by buttons which the subject must press. Blind alleys are represented by a signal flashed before the subject, and the true course by another signal. Each pressure of

[8] Miles, W. R., "The High Relief Finger Maze for Human Learning," *Jour. Gen. Psych.*, 1928, Vol. I, pp. 3–14.

[9] Henderson, A. Lee, "A Problograph for the Study of Human Learning," the Ohio State University. Unpublished.

a button is recorded electrically upon a tape. Any pattern can be quickly set up, and thus a great diversity of maze patterns are allowed for.

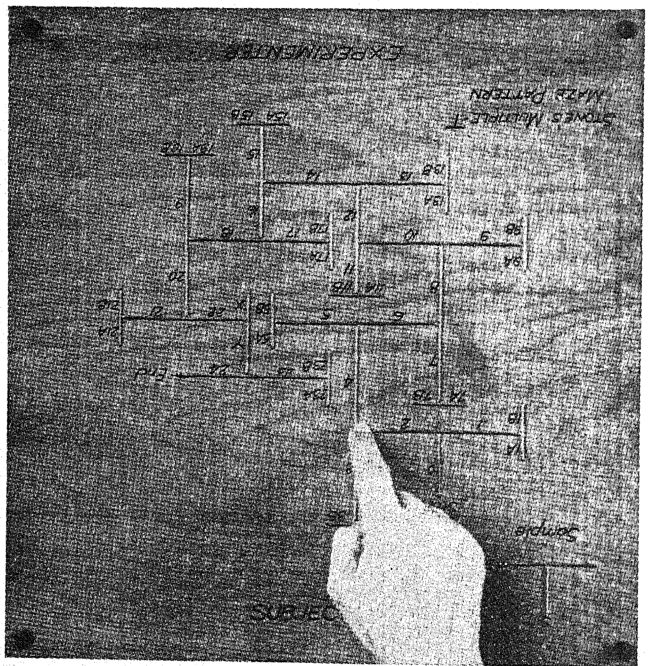

**Figure 65.—The High Relief Maze.** (From Miles, "The High Relief Finger Maze for Human Learning," *Jour. Gen. Psych.*, 1928, Vol. I, p. 8.)

**Comparison of human and animal learning.** In a typical experiment, the performance of rats and human subjects was compared. The human subjects were required to draw their fingers along a high relief finger maze while blindfolded. The maze for the rats was identical in pattern, but was adapted so that the animals could run through the alleys. The criterion for the two groups was 3 errorless trials in succession. The human

subjects, learning the maze all at one sitting, met the criterion in an average of 16.7 trials, while the rats, running one trial a day, required on the average 24.2 trials to attain the same proficiency. (The learning curves for rats and human subjects are very similar, the rats consistently requiring a little more time and making a few more errors throughout the length of the experiment.)

It must be remembered that the two situations are not entirely comparable. In the first place, the rats must go bodily through the maze, covering a total distance of 30 feet, while the human subjects do a miniature manual performance over a space of 3½ feet. In the second place, the rats are driven by hunger only, and are therefore merely driven to general activity until they have once found food. Gradually, we may assume, the rats are increasingly motivated by the goal. (The human subjects have been instructed and understand what is to be done. They are motivated with reference to the goal on the first trial.) The results of this difference in motivation are indicated by the order in which the errors or blind alleys are eliminated. The human subjects are more inclined to eliminate the blind alleys at the beginning of the maze more rapidly, while the rats eliminate the alleys at the end of the maze first and gradually eliminate farther and farther from the food.

**Significant features of maze learning.** We have seen that both animal and human subjects exhibit many characteristics in common during the course of learning a maze. It requires a number of trials before a subject of either class can go directly to the goal with the minimum amount of effort and in the shortest possible time. During the first trial, there is a great deal of random activity, but this is narrowed down to the general location of the correct path in the maze. (The whole performance

may be described as a "hit-and-miss" or "trial-and-error" activity. The curves of learning for both human and animal subjects are very similar. The first trials require a great deal more time, but there is a rapid improvement during these first few trials, and then progress is slower until the maze is finally learned. Also, the curves for any individual animal do not show a constant progression toward perfection. One trial may take somewhat longer than the preceding trial. Errors that are made at one time may not be made the next time, but some other blind alley may be entered. By what means does the animal come finally to eliminate the useless acts and to select and retain those acts that lead directly to reward? Several interpretations as to what is taking place during this learning process have been given.

## Explanations of Maze Learning

**Selection and fixation.** Before we consider the various explanations that have been proposed, it is necessary that we point out the distinction between "selection" and "fixation." When, after the first trials, the animal ceases a certain useless movement or omits to run into a blind alley, we say that he has eliminated an error or that he has selected a correct act rather than an incorrect one. This does not mean that he will always do so. At one time he may make one complete run through the maze without an error, and the very next time he may make several errors. Or, he may omit one blind alley one time and enter it another time. With repeated correct runs, the performance becomes more and more automatic; that is, the correct turns become *fixated.* In the earlier correct runs, any distraction may throw him off, and he begins a hit-or-miss performance again.

After thorough fixation, this difficulty is not so likely to occur.

(It may be assumed that, other things being equal, those acts most frequently repeated are most likely to be established as habits.) In the maze experiment, if the animal enters a blind alley, he must eventually traverse the correct route. On other occasions, he misses the blind alley and still traverses the correct route, and hence accumulates more runs in the true path than in the blind. There are some difficulties with this description as an explanation of the learning process. The animal may traverse a blind several times before he enters the true path. Also, if, after he has traversed a long route to the goal several times, a shorter route is opened, he will investigate this new feature in the maze and after a very few trials will take the shorter route in preference to the long one though he has traversed the long one many more times. This merely means that, even in the case of the simple learning of the rat, there must be some factor other than frequency that acts as a *selective* principle.

**The "law of effect."** In the discussion of motives (Chapter XI), we saw that physiological conditions which stimulated the animal to activity were satisfied when the behavior of the animal brought about a change in the physiological condition. In the maze experiments, the rat is motivated sufficiently by hunger. When he finally reaches the end of the maze, his hunger is partially satisfied by a small amount of food. Gradually, he becomes motivated with reference to this specific goal, and those particular ways which are most intimately related to the food become established as a part of the activity of food getting. Hence, we can see that, for the rat, in the early trials the alleys at the end

of the maze may be included in the animal's configuration or pattern to be dealt with, and the true pathways in that section of the maze may become definitely associated with food. Gradually, a total pattern of reaction with reference to this goal is built up. In the human subject, the individual's understanding of the instructions and of the character of a maze makes it possible for him to attack the problem as a whole. For this reason he is more prone to eliminate the blind alleys at the beginning than to follow a course of reaction similar to that of the animal subject.

**Recency as a factor in selection.** It has been proposed as an explanation of animal learning that those actions which are most closely associated with a stimulus are most likely to be repeated on another occasion. Thus, the rat learns the end of the maze first because the last act—that of traveling the last alley—leads to food.

**Dynamic relations involved in selection.** We have frequently described the maze performance as the hit-and-miss selection of alleys or the "trial-and-error" method of learning. This is hardly an accurate description of what is taking place. When the hungry animal reaches an intersection, he must make a choice. This choice will depend upon his total adjustment to that particular situation. If he enters a blind, it is because he is adjusted for that direction rather than for the other. Having reached the end of the blind, he meets a new situation to which he can react by retracing the blind and either continuing along the correct route or moving toward the starting point. At each point in the maze, therefore, he will be making choices on the basis of his posture.

The second time that the subject goes through the maze, the intersections will present to him situations different from those that they presented the first time, because his total posture has been changed by the previous experience. Each trial, therefore, is presenting an opportunity for the subject to make the correct adjustment to the total situation. The correct paths are gradually selected because of their direct relation to the goal. Frequency is only one factor in this process. It is the combination of the posture or motive of the animal, the satisfaction of the motive, and the intervening activity which is required to bring about the satisfaction. Repetition is important in the final analysis, but it is repetition of specific acts within the total pattern in relation to the performance as a whole.

**Importance of the goal.** The relation of posture to the goal as explained in the above paragraph is illustrated by an experiment in which the reward was omitted. One group of rat subjects ran 10 days without being fed in the maze, but was given food after each trial for the remainder of the experiment. Another group was rewarded the first 10 days but was not fed in the remaining trials. The results are indicated in the error curves of Figure 66. It will be seen that the first group of rats shows improvement during the first 10 trials but that the improvement is greatly increased after the reward is introduced. The initial improvement of the second group of rats during the reward period is much superior to the initial improvement of the first group, but during the period of no reward the number of errors increased. The fact that the first group improved during the no-reward period may be explained on the assumption that release from the maze was in itself

a reward. This group also gained during this period some familiarity with the maze which improved its performance when food was introduced as a reward.

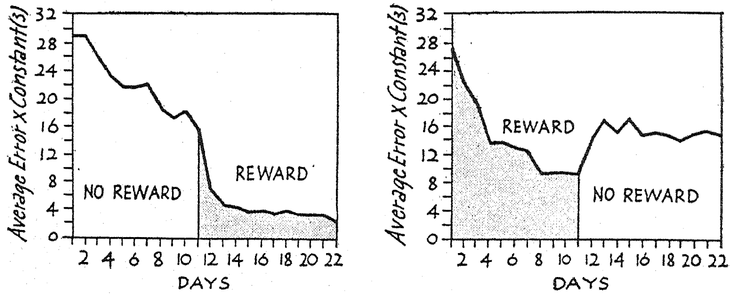


**Figure 66. Error curves (a) with no reward until the eleventh trial and (b) with reward for first ten trials only.[10]**

**Negative effects of repetition.** The fact that the total adjustment is involved in the learning process is illustrated by experiments in the breaking of undesirable habits. It has been found that if a person has a habit which is annoying to himself or to others, he can break this habit by repeating it. In one instance, a subject was bothered in typewriting by writing *hte* instead of *the*. In order to break this habit, he wrote *hte* until he had filled a page and a half of paper. After that he never made the error. Similar success has been achieved in the curing of stuttering by requiring the subject to stutter in regular practice periods. Biting the finger nails and other automatic performances or mannerisms respond to this technique. The undesirable habit is stamped out not because the subject repeats the act, but because he is forced to repeat it as a unit performance. As a result, the undesirable habit loses its integration with other activities. These illustrations merely show that learning involves a complex organization of the

[10] Tolman, E. C., and Honzik, C. H., *Univ. Calif. Pub. Psych.*, 1930, Vol. IV, pp. 241–275. Adapted by Woodworth.

subject with reference to the specific situation. In an earlier discussion of the conditioned reflex (page 123), we saw that it was not merely a matter of repetition of the stimulus which established the reflex, but that it was necessary that the animal be hungry, that distracting stimuli be eliminated, and that the animal be kept in a specific posture with reference to the stimuli used. Even in this simple example of learning, we must take into account the total organization of the individual with reference to the specific environment.

**Conclusion.** From the foregoing discussion of learning, we may evolve the principle that all learning requires activity. We must actually hit upon the proper adjustment with reference to the situation before we can learn it. In other words, we learn by doing. We may not be able to analyze the specific elements in the total adjustment, but it is only by repeated attacks upon the situation that we finally become skillful in our response.

## The Learning of Skills

In the preceding experiments with human learning, the principal task was the learning of a series of acts, each of which involved little or no skill not already possessed by the subject. To walk through a maze blindfolded or to draw a stylus through one involves only activity of an everyday sort that has been practiced so long as to have become automatic. All that is really new is the pattern of the movements that must be made.

**Mirror drawing.** A quite different task is the development of *new* motor coördinations. This is simply illustrated in the mirror-drawing experiment. A mirror is placed in an upright position before the subject. Some figure—for example, a six-pointed star—is placed in front

of the mirror and shielded from the subject by a horizontal screen so placed that the figure can be viewed only in the mirror. The subject's hand, holding a pencil, is placed at the starting point of the star, and he is required, with hand and arm free from the table, to trace the star by its mirrored image as rapidly and as accurately as possible. Usually, the star is drawn with a double line, and the subject is instructed to keep within these lines.

In the first trials the subject will experience great difficulty in making the proper movements. With repeated trials, he becomes more proficient until, at about the thirtieth trial, he can complete a tracing without error in approximately fifteen seconds. When the time for each trial is plotted, the improvement in speed displays a typical learning curve.

This is an illustration of the development of eye-hand coördination similar to the infant's learning to reach and take an object. In mirror drawing, however, motor habits which have already been set up must be reversed. What is accomplished is not the destruction of these previous habits, but the learning to disregard them in the new situation. It is simply the learning of a new act, much the same as the learning of any skill—such as skating, swimming, or using tools.

One important feature is that mere analysis of the situation does not solve the problem. To observe each move may facilitate the learning, but the subject is still left to "trial and error" for the mastery of the performance. He must hit upon the correct movements in very much the same way as he hits upon the correct turns in the maze.

**Learning telegraphy.** One of the outstanding records of the acquisition of a complex motor habit is that re-

ported by Bryan and Harter in the learning of sending and receiving telegraphic code. Once each week, the student was tested for the number of words he could send or receive in several 2-minute periods, and the results were averaged so that his accomplishment could be determined.[11] Figure 67 represents the improvement of one subject for each of these performances. The curve for sending rises rather rapidly during the first weeks of the practice and then seems to approach a limit, while the receiving curve rises more slowly until about the fifteenth week, when improvement appears to be almost at a standstill. At about the twenty-fifth week, the receiving curve began to rise again, but it never reached the level of the sending curve.[12]

There are, then, two outstanding features in learning telegraphy:

1. One can learn to send code more rapidly than to receive. It is easier to organize the response from the familiar (reading) to the less familiar (code) than it is to adjust oneself to the unfamiliar (code) and respond with the familiar (writing).

2. Sending code is a gradual process of learning which progresses rapidly at first, then more and more slowly; while receiving presents a period of apparently no improvement—the plateau—followed by improvement.

**The plateau.** It is quite frequent for plateaus, or periods of no progress, to be displayed during the acquisition of complex performances, such as telegraphy,

[11] Bryan and Harter, "Studies in the Physiology and Psychology of the Telegraphic Language," *Psych. Rev.*, 1899, Vol. IV, pp. 27–53; 1899, Vol. VI, pp. 345–357. This study is important because it was one of the first to be performed in the modern field of learning.

[12] This is because the experiment was not continued long enough. Experienced telegraphers can receive faster than they can send; therefore, at some time after 40 weeks curve *R* will cross curve *S*.

typewriting, ball tossing, and golf. At first thought, we might assume that this period of no gain is due to a loss of interest or enthusiasm, or to discouragement and inattention; but this should also be true for sending code and for other forms of learning as well. A better explanation seems to be that the curve represents more than one task—that we really have two learning curves. In receiving code, it was found that the student must distinguish first separate letters, then words. Some time elapsed before he could grasp whole phrases.

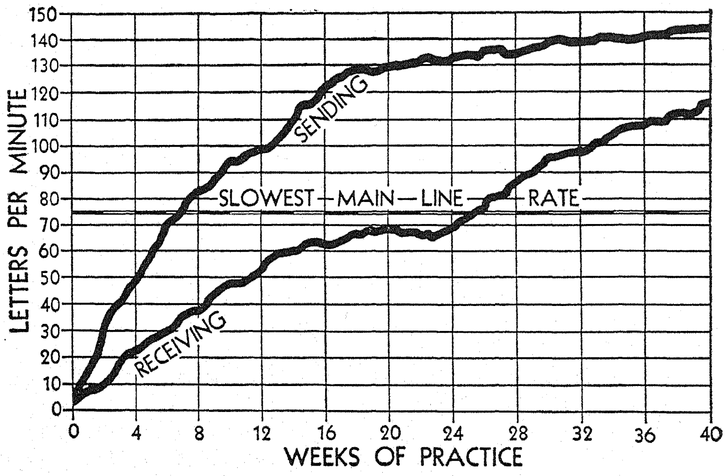


**Figure 67.—Practice Curves in Learning Telegraphy.** (*Adapted from Bryan and Harter.*)

An interpretation of the receiving curve, therefore, would be that by using one mode of attack the subject can attain only a certain efficiency, probably about 50 letters per minute. He must then change his attack—that is, he must handle words or syllables instead of separate letters. His efficiency then continues to increase until at the end of 40 weeks of practice he can

receive about 90 letters per minute. Further improvement consists in his being able to handle whole sentences as units, and this ability eventually permits the receiving rate to exceed the sending rate. The experiment, however, was not continued long enough for this process to occur.

**Ball tossing.** Ball tossing, or juggling, is a task composed of several distinct problems.[13] Three important factors in this task are:

1. The control of force, or of the distance the ball is tossed.
2. Direction.
3. Timing, so that the hand may be closed to catch the ball.

In tossing two balls with one hand, one must throw the first ball high enough to allow for tossing the second, but tossing too high interferes with the other movements. The balls must not be tossed straight up, or they will collide; but throwing at too great an angle increases the difficulty of catching and tossing. The performer must look in the direction of tossing, and hence cannot see the ball as it nears the hand; but he must start closing his hand before the ball strikes, or he will not close it quickly enough. These may be considered three distinct tasks to be learned.

When separate experiments, each representing one of these tasks, were performed, no plateau appeared. (This fact is rather conclusive evidence that a period of no improvement indicates a complex task, and that, if the task is broken up into its elements, no plateaus will appear.)

[13] Batson, W. H., "Acquisition of Skill," *Psych. Mono.*, 1916, Vol. XXXI, No. 3.

**The principles of acquiring skills.** We acquire skills by the same processes employed in learning a maze or in any other type of learning. (The chief difference is that a great deal of what we learn is only partially learned and therefore easily forgotten, while skills are overlearned.) That is, we continue the practice or the repetition of the situations involved in the practice of the skill until the act is learned to a much greater degree than in an ordinary situation. For example, we have seen that in some maze experiments the criterion of learning was the ability to run the maze three times in succession. The telegraphic operator learns to send messages far beyond the standard of three successive operations. His problem is to develop such facility in reacting to the code situation that he can react with perfect ease; in all other respects, the process is not unlike that of other learning. If you wish to learn to drive a golf ball, you may practice at the tee twenty or fifty times every day until you have reached a standard of efficiency which you have arbitrarily set as your goal. Each drive is a new trial in which you attempt to make the proper adjustments just as the rat does in the maze. It is possible to make many random movements, which correspond with blind alleys. Occasionally you hit upon a part of the pattern which you believe is successful. The next time, you attempt to reproduce the same movement, but without success. Little by little you build up a total pattern of response which meets with your approval. However, it is only by repeating this situation over a long period that you are able to predict how well you are going to perform.

We have learned in this way many skills which are so common that we do not realize their complexity. We are skillful in speaking our native language and in re-

ceiving communications from another. For the child three years old speaking is a very complex process and involves much effort in organizing the vocal apparatus for the proper enunciation of words and the formulation of a sentence: he must go through the same process of readjustment time and again before he reaches the standard of perfection of the speech of the adult.

## Questions for Review

1. How many of the performances which you carry out in one day are learned? What does this indicate regarding the importance of an understanding of the nature of the learning process?

2. What is meant by a social criterion of learning?

3. Distinguish among learning, memory, and habit.

4. What are some of the important questions regarding learning which the psychologist seeks to answer?

5. What is the chief distinction between animal learning and human learning?

6. Why is the psychologist interested in learning in the lower forms?

7. What are the conclusions regarding the presence or absence of learning in the protozoa and coelenterates?

8. Briefly describe the experiments which lead to the conclusion that learning occurs in each of the following animals: earthworm, fish, chicks, rats.

9. What are the conclusions to be drawn from the work with pecking in chicks? Why should one interested in human psychology take any interest in these results?

10. What problems in learning may be investigated by the use of the maze and the puzzle box?

11. What are some of the factors which hinder a rigid comparison of animal and human maze learning? What comparisons between animal and human learning may be satisfactorily made? What do these comparisons show?

12. Distinguish between selection and fixation.

°13. In what way do physiological tensions become a part of the learning process?

14. To what extent is the total posture of the organism operative in the learning situation? What are some of the learning phenomena which a knowledge of this posture may be used to account for?

°15. In what ways does the acquisition of a skill resemble maze learning?

°16. What may be one reason why most skills seem to be retained longer than other habits?

17. What particular aspect of learning is demonstrated by the mirror-drawing technique? List some everyday examples of learning under similar conditions.

18. What steps may be taken to prevent the occurrence of a plateau in a learning curve?

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## CHAPTER XXIV

# Economy in Learning

The first attempt at a scientific investigation of memory was made by Ebbinghaus with "nonsense" syllables. These syllables are formed by two consonants with a vowel between; all combinations that form a word or that are too suggestive of meaning are avoided. (The object is to set up a series of syllables of uniform length and to eliminate so far as possible unequal difficulty by selecting syllables that do not already have preëstablished associations.) Meaningful words have the disadvantage that some are more familiar to the subject than others and also frequently go together in the series to form meaningful combinations.

These difficulties are not always avoided with the nonsense syllables. For example, in such a list as *fuj, dil, tup, rem, mox, hab, coz,* each syllable may, with some study, be recognized as a part of some familiar word or as similar in sound to an actual word. Thus, *fuj* becomes *fudge,* and *dil* suggests *pickle.* One subject remembered the combination of *coz-ruj* by saying that his *cousin* had asked him to buy her some *rouge* that afternoon.

To avoid some of these difficulties, a long list of syllables was submitted to a large number of subjects who reported those that they associated with anything. After all associated syllables had been eliminated, there remained about three hundred that had not been re-

ported as suggesting any connection. Such a procedure of elimination is not always necessary, as the subject after a time ceases to associate nonsense syllables with other words. Three-letter words may then be inserted and the subject will not recognize these syllables as words at all.

**Effect of length of series in learning nonsense syllables.** The first experimental study involving nonsense syllables was made by Ebbinghaus in 1885. He was interested in the practical problem of the relation of difficulty to the length of time required for learning. To illustrate: If it requires 6 trials to learn a list of 6 nonsense syllables, will it require 12 trials to learn a list of 12 syllables? If it requires fewer than 12 trials, then there would be some advantage in learning relatively long lists; if more than 12, there would be an advantage in learning the shorter lists.

Ebbinghaus's results are shown in Table X. From

TABLE X

THE NUMBER OF REPETITIONS REQUIRED TO LEARN NONSENSE SYLLABLE SERIES OF DIFFERENT LENGTHS (Ebbinghaus)

| *No. of Syllables* | *No. of Repetitions* |
|---|---|
| 7 | 1 |
| 12 | 17 |
| 16 | 30 |
| 24 | 44 |
| 36 | 55 |

them he concluded that the number of repetitions required for the longer tasks increases at first with great rapidity and later with less rapidity, the increase in repetitions being relatively much greater than the increase in the number of syllables.

**Whole versus part learning.** When one proceeds to learn a poem, he normally reads the first stanza until he can recite it, then reads the next stanza or the next few lines, and adds them to the first stanza. In some cases, one reads and rereads the entire poem, making added repetitions for the more difficult parts. The question as to whether the whole method—that is, reading the entire poem each time—or the part method is the more economical in learning is a problem which has been dealt with by various experiments.

In one investigation [1] it was found that, even though long poems were used, the whole method was superior, and that the saving increased as the length of the poem was increased. A 240-line poem was learned by the whole method with a saving of 20 per cent over an equivalent amount learned by the part method. In another experiment in which both poetry and nonsense syllables were used, it was found that for poems the whole method was 9 per cent better than the normal method of learning, but that for nonsense syllables the results were at first reversed. Further practice with nonsense syllables, however, gave practically the same results as were obtained with poems.

Other investigators have obtained opposite results. One divided school children into two groups of equal age and ability, determined by preliminary learning tests, and gave one group poems to learn by the part method and the other the same poems to learn by the whole method. He found an advantage of 26 per cent in the part method.

Pechstein [2] performed several experiments with a maze

[1] Pyle, W. H., and Snyder, J. C., "The Most Economical Unit for Committing to Memory," *Jour. Educ. Psych.*, 1911, Vol. II, pp. 133–142.

[2] Pechstein, L. A., "Whole vs. Part Methods in Motor Learning," *Psych. Mono.*, 1917, Vol. XXIII.

with both rat subjects and human subjects. The maze was designed with four parts, any of which could lead to the food box or to the next part. He used the following part methods:

1. Pure part, learning each section separately, then running the whole maze.

2. Progressive part, learning section 1, then section 2, learning 1 and 2 together, then learning 3, and so on.

3. Direct repetitive, learning 1, then running from 1 to 2. When this was learned, 3 was added, and then 4.

4. Reversed repetitive, learning in the order of 4, then 3, and so on.

In some experiments by the whole method, the subject was allowed to retrace as far as he wished; in others the retracing was restricted to that permitted by the part methods. Table XI gives some of the results.

It would appear from Pechstein's investigation that the progressive-part method is more economical than either the pure-part or the whole method. (The question certainly is not definitely answered.) When we take into consideration all of the experiments dealing with this problem, we may conclude on the basis of the data compiled that there are a number of factors influencing a brief for one method or the other.

First of all, whether one can learn better by the whole or by the part method depends largely upon his previous habits of learning. If he has done a great deal of memorizing by the part method, the whole method would not be so advantageous. More important, however, seems to be the degree of maturity or the intelligence of the learner. For a selection of given length, the whole

TABLE XI

WHOLE VS. PART LEARNING FOR RATS AND HUMAN SUBJECTS
(After Pechstein)

| *Method* | *No. of Rats* | *Av. Trials* | *Av. Time (Sec.)* | *Av. Total Errors* |
|---|---|---|---|---|
| Progressive part | 9 | 11 | 662 | 65 |
| Reversed repetitive | 8 | 17 | 882 | 76 |
| Direct repetitive | 11 | 21 | 1442 | 142 |
| Whole—returns prevented | 9 | 30 | 1666 | 111 |
| Pure part | 9 | 30 | 1907 | 199 |
| Whole—returns allowed | 12 | 27 | 4174 | 217 |
| *Method* | *No. of Human Subjects* | *Av. Trials* | *Av. Time (Sec.)* | *Av. Total Errors* |
| Progressive part | 6 | 10 | 352 | 57 |
| Reversed repetitive | 6 | 22 | 1014 | 226 |
| Direct repetitive | 6 | 11 | 618 | 96 |
| Whole—returns prevented | 6 | 17 | 541 | 81 |
| Pure part | 6 | 23 | 1220 | 237 |
| Whole—returns allowed | 6 | 12 | 641 | 126 |

method is more advantageous for the more intelligent or mature subject than it is for the one of less ability. In other words, if the subject is able to grasp the significance of the whole, his rate of learning will be greater when he reads the entire section through each time. If he cannot grasp the content of the whole, the material must be broken up into smaller wholes and he must learn these separately.

**Distributed versus concentrated repetitions.** (Learning with periods interspersed between recitations is

TABLE XII

EFFECT OF DISTRIBUTION OF REPETITIONS ON ECONOMY OF LEARNING

| *Recitations per Day* | *Days* | *Syllables Remembered* | |
|---|---|---|---|
| | | *Subj.* M | *Subj.* B |
| 8 | 3 | 7 | 18 |
| 6 | 4 | 39 | 31 |
| 2 | 12 | 53 | 55 |

definitely more economical than learning in which all the recitations are concentrated into one period, under most conditions.) Table XII gives the results for two subjects when nonsense syllables were used. It will be seen that for each subject there is a constant gain in the number of syllables remembered when the number of recitations per day is decreased.

In another experiment, the subjects were required to write numbers corresponding to letters in a prearranged chart. The progress of learning is shown in Figure 68. The first group worked for 10 minutes twice a day; the second group, 20 minutes once a day; the third group, 40 minutes every other day; and the fourth group, 120 minutes at one sitting. The greatest progress was evidenced by the group with the greatest distribution of practice, 10-minute periods twice a day.

It appears, therefore, that on the whole a judicious spreading out of the work in learning will be more productive than attempting a complete mastery at one sitting. How much the distribution should be extended must be determined, of course, for practical purposes, by the time intervening before the material learned is to be used. Results of investigations show that the student who does a part of his work every day will accom-

plish more than if he lets the work pile up until near the end of the term and then crams. Such a student gains a double advantage inasmuch as the total effort to reach the same standards of excellence will be less and the permanence of the learning will be greater.

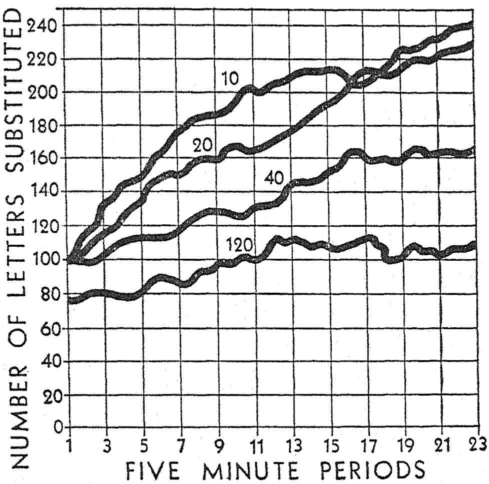


**Figure 68.—Practice in Writing Numbers for Letters According to a Key.** (*Starch.*)

(Concentrated effort seems to have an advantage in the fact that one gets warmed up to the task and succeeds in eliminating distractions.) The work period should, therefore, be long enough to permit this "warming up," although it should not be so extensive as to necessitate neglect of the distribution of work periods. Concentration every day, or every other day, on the same material is most effective. This means that one frequently reviews the material already worked upon, rather than learning a section at a time. It involves the "whole" and "distributed" methods as opposed to the "part" and "concentrated" methods.

**Explanations of the superiority of distributed effort.** There are three possible reasons why it is more economical to distribute the repetitions in learning over a period of time:

1. It avoids the effects of fatigue.
2. It permits perseveration, the continued nervous activity.
3. It eliminates errors and incorrect adjustments.

It is not difficult to understand that long periods of concentration are likely to induce fatigue, which would cause a lowering of efficiency. Ordinarily, fatigue is not so important a factor as one might assume. Experimental studies of fatigue indicate that one may work for relatively long periods without any appreciable loss of efficiency.

The second explanation is purely hypothetical. It assumes that, following stimulation, the nervous system is for some time still active. Hence, if 10 repetitions are given in immediate succession, only the last one gives an opportunity for this perseveration process. If the repetitions are distributed, this process functions after each reading.

The third factor is evidently of considerable importance. When one is first performing a task, he makes many errors or wrong moves. Continued repetition results in an insistence of these errors to recur. Ordinarily, when we realize this condition, we lay aside the task until another day; then when we return to it, we find that we can perform it more easily.

The same tendency is observed in the white rat in the maze. With concentrated repetitions, the rat confines his activities to the same blind alleys and retracings. With distribution of repetitions, the activity is more

varied and the blind paths are less likely to become established. This again emphasizes the fact that what we call "repeating" is, actually, attempting a new adjustment. When you are studying and find that you are not able to understand what you read, you may sit back and relax a few seconds and then start again. The distribution of repetitions is merely an example of this process. You read the list of nonsense syllables and then leave it to come back with a new adjustment. Each so-called "repetition," therefore, is a presentation of the situation in which you are afforded the opportunity to establish a relationship in your response to the subject matter.

Probably, therefore, all three factors play some part in effecting the superiority of the distributed repetitions, though not necessarily an equal part in all cases. Fatigue will play a slight rôle, except possibly when a lack of interest predominates; perseveration, or some mechanism of establishing the associations formed, may be of some importance, though just what this mechanism is, is not certain; the dropping of errors or interfering acts is important not only in such performances as skillful acts and maze learning, but also in all types of verbal learning.

**Effect of interspersed recitations.** Though reading aloud a series of nonsense syllables or other material to be learned involves activity, it is found that the more definitely active performance involved in attending to recall increases the degree of learning. Thus, in one experiment in which a list of words was read to the subject and between the readings the subject attempted to recite the list, it was found that the material was learned with fewer repetitions than were required for learning a list of equal length without interspersed recitations. In

general, the gain with interspersed recitations was found to be 14 per cent. If a student reads an assignment, then attempts to write or outline orally the subject matter that he has read, and finally rereads it, his results will show a very definite gain over his results with the usual method of reading the material and simply attempting a recitation.

**The effect of age on learning.** As an individual passes from infancy to maturity and old age, his ability to adjust himself to new environmental situations changes. At what age is he most able to make these new adjustments? It is usually considered that somewhere between infancy and maturity he reaches his maximum of learning ability. The child or youth learns more readily than the older adult. Yet there are many situations to which the older person is more capable of adjusting than he would have been at the earlier age.

This complication is undoubtedly due to the fact that, while the older person is not more able to learn new facts, he is less frequently confronted with anything entirely new. Many previous experiences have involved elements of the supposedly new, present situation. He has also acquired certain habits which now interfere with new adjustments, and these habits would partially offset what he gains by previous experience.

With rats whose diet was carefully controlled according to its effects upon body weight, there was no significant difference in the maze learning of the various age groups, though there was still a question as to whether the incentive was equal for all groups. With human subjects, the tasks have included drawing lines blindfolded; writing with the non-preferred hand; and learning code, elementary-school subjects, typewriting, and so forth. The curve in Figure 69 is suggested as a fair

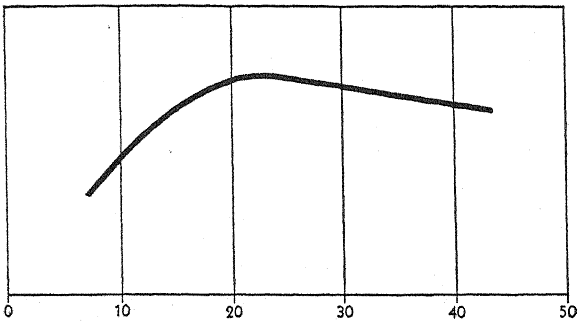


Figure 69.—The General Form of the Curve of Ability to Learn in Relation to Age in Human Subjects. (*Thorndike.*)

generalization of the relation of age to learning in human subjects. (The general conclusion is that, in general basic modifiability, the old are considerably inferior to those about 22 but compensate for this inferiority to some extent by better appreciation and organization.) The factor of motivation in this case too is difficult to evaluate.

**Retention and forgetting.** We have previously pointed out that there can be no learning in the absence of some degree of permanency or retention of the modification set up by the response. On the other hand, it is a well-recognized fact that with disuse, learned responses fade out as time passes. Several facts from everyday experience are to be noted:

1. Some persons forget more rapidly than others.
2. We all forget some things more quickly than we do others.
3. Under some conditions we forget what we would easily retain under more favorable conditions.
4. In some cases, particularly with acts of skill, there seems to be improvement with the lapse of time.

Two questions regarding the nature of forgetting naturally arise:

1. Does the learned response merely fade with the lapse of time as a photograph fades when long exposed?

2. Is forgetting due to the interference of the succeeding activities?

We all frequently find that we fail to recall a fact once learned apparently because it was learned a long time ago or because other activities have interfered with our use of it. The student is confronted with the problem of acquiring facts in several courses at the same time. He forgets one set of facts while learning another.

The practical problem resolves itself into the determination of what are the most efficient methods of acquiring the great mass of facts and skillful acts that are required in a highly complex life so that the individual will be able to make use of them with the greatest degree of certainty. To arrive at a satisfactory conclusion, we must examine the findings of investigations into the nature of retention, forgetting, and inhibition.

**The rate of forgetting.** When series of nonsense syllables were learned to the point where they could be recited once correctly, Ebbinghaus found that the initial loss of retention was greater than the loss in succeeding intervals. Thus, his loss was 41 per cent in the first 20 minutes, but only 60 per cent in the first hour. Other investigators have obtained similar results when the material was barely learned (to a point allowing one correct repetition); but where the material was overlearned—that is, when it could be recited correctly two or more times—the curve of the forgetting falls more gradually. Table XIII gives results of Ebbinghaus and of one investigator who required two correct recitations.

TABLE XIII

THE PER CENT RETAINED FOR NONSENSE SYLLABLES AND POETRY
(from Ebbinghaus and Radosavljevich)

| Period after Learning | Ebbinghaus | Radosavljevich | |
|---|---|---|---|
| | *Nonsense Syllables* | *Nonsense Syllables* | *Poetry* |
| 5 min. | .. | 98 | 100 |
| 20 min. | 59 | 89 | 96 |
| 1 hr. | 44 | 71 | 78 |
| 8 hrs. | 36 | 47 | 58 |
| 24 hrs. | 34 | 68 | 79 |
| 2 days. | 28 | 61 | 67 |
| 6 days. | 25 | 49 | 42 |
| 14 days. | .. | 41 | 30 |
| 21 days. | .. | 37 | 48 |
| 30 days. | 21 | 20 | 24 |

**Degree of learning and rate of forgetting.** It is assumed that the rate of forgetting is much more rapid for verbal material than it is for non-verbal material, particularly those non-verbal acts that are classed as acts of skill. It is often found that, after as much as a year of no practice, the subject can do as well as or better than he did on the last day of practice. It should be remembered, however, that acts of skill are *over-learned* responses in the sense that they have been performed correctly more than once. One may readily learn the keyboard of the typewriter and the correct position of the fingers so that he can write correctly according to the standards set for reciting nonsense syllables, but he is a long way from being a successful typ-

ist. Constant repetition is necessary before the series of acts becomes properly fixated and the useless and interfering acts become completely eliminated.

This point may be better illustrated by the familiar example of learning to drive a car. The novice may appear to drive correctly, but he gets tired. After several days he says that he is "getting used to it." The same is true with verbal learning. The student may be able to solve the problems assigned in mathematics or to "get by" with a recitation in history, but he is a long way from possessing the ready command of the material that the professor, who has repeated it many times, possesses.

**Forgetting and inhibition.** So far, we have considered forgetting as a fading-out process. A second possibility is that forgetting is due to the activities that follow learning in the sense that they interfere with, or inhibit, the previously learned response. The problem may be stated more definitely as follows: After a given material has been learned, what will be the effect of immediately succeeding activity upon retention? Will a passive period be more conducive to retention than an active period?

The experimental procedure is to allow a given number of repetitions for learning, and to give the test after a predetermined interval. The intervening period is occupied with some definite task, desultory newspaper reading, or complete passivity. The latter is never actually attained, of course, and the degree of passivity cannot be determined.

It has generally been found that the subjects do better after an interpolated rest than after work. However, in one investigation, the subjects reported that they often caught themselves repeating the material during

the rests.[3] If this were true in the other experiments, it would seem to indicate that the superiority following rest was the result of further practice rather than of the absence of interfering activities' destroying the retention.

Retention during sleep. *Rest* is a relative term. Sleep is considered a more complete rest or a lower degree of activity. We would not expect the subject to repeat or practice the material during sleep.

Two subjects were allowed to sleep 1, 2, 4, or 8 hours immediately after learning a series of nonsense syllables. The results of tests following these periods were compared with the results for equal waking periods. Figure 70 shows that the loss was considerably greater for both subjects following routine work than after sleep.[4]

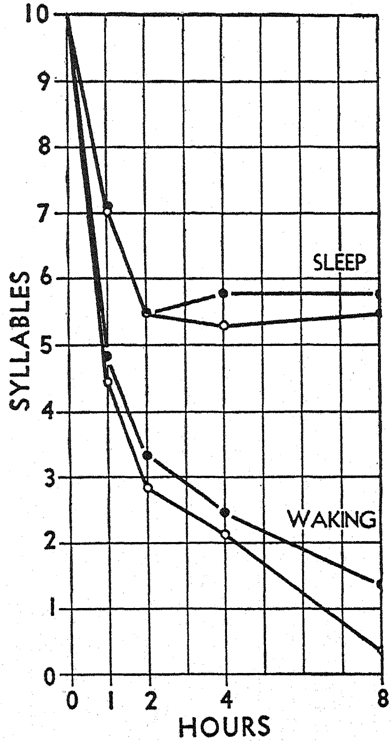


Figure 70.—Curves Showing the Loss of Learning During Sleep and Waking States for Two Subjects. (*Jenkins and Dallenbach.*)

Speed of learning and degree of retention. It is frequently claimed that the slow learner has the advantage over the

[3] Skaggs, E. B., "Further Studies in Retroactive Inhibition," *Psych. Mono.*, 1925, Vol. XXXIV, No. 161.

[4] Jenkins, J. G., and Dallenbach, K. M., "Obliviscence During Sleep and Waking," *Amer. Jour. Psych.*, 1924, Vol. XXXV, pp. 605–612.

quick learner in that he will not forget so readily. "The quick learner is the quick forgetter." Evidently this notion is based upon two inadequate observations. In the first place, this impression is handed out to the slow, plodding student as encouragement for his effort. In the second place, we frequently meet a slow but faithful student who ultimately succeeds in attaining relatively high standards of accomplishment. Experimental evidence indicates, however, that while there is little correlation between the rate of learning and the rate of forgetting, the advantage for retention is on the side of the quicker learner. The difference between the degrees of retention of the slow and quick learners is greater for nonsense material than for logical material.

**Summary.** We may conclude that there are several factors influencing retention:

1. The degree of learning is an important factor. That material which has been most completely organized, either because it has been given frequent repetitions or because it fits in most easily with the previous organization of the individual, is most likely to be retained.
2. Forgetting is for the most part a gradual fading out of the reactions once acquired. Occasional repetition, or review, is essential if one desires to keep the habit or material once established.
3. Other activities interfere with the learned response and thus hasten the fading-out process.

The student is generally confronted with numerous types of activity which interfere with effective learning and retention. For this reason, the student who learns more slowly often makes a better showing on the final examination than his quicker associate. He may limit the number of social activities into which he can be

drawn, and thus there is less to interfere with his retention of what he has acquired.

From the foregoing analysis of retention, we may conclude that forgetting is due both to a fading out of habits once established and to the inhibition or destruction of these previously learned patterns by the activities that follow them. It would seem that little can be done to prevent the natural decay, but that the rate of forgetting can be greatly retarded by reduction of the amount of succeeding activity, particularly immediately after learning. Frequent reviews and the avoidance of activities too remote from the material learned will benefit the retention. In other words, the student who lives most nearly in the realm of his important endeavors will be most successful in this field.

**Recall requires stimuli.** (When an act has been learned, it can be repeated at a later date only if the situation presents the proper stimuli or cues, that is, those that were present when it was learned.) The situation need not, of course, be an exact duplicate of the original; but the essential feature, such as a word, a sound, or even a need that was planned at the time of learning, must be present. Many times, the cue or stimulus may be very remote, as, for example, when we say, "I don't know why I thought of that," or "I don't know why I did that." Many times, the act can be performed only when the original situation is closely duplicated; that is, a great variety of cues are required. For example, the student fails to answer a simple question, but several questions on the same topic may elicit the correct response.

If we attempt to analyze the factors that influence our ability to repeat partly or wholly what we have previously learned, we find that those factors which have

been listed as the conditions of attention are important here too. (The strength of the stimulus is represented by the situation presented, its conformity to the original situation, the number of elements included, and the relative intensity of these elements. On the more personal side are such factors as the "set" or posture of the moment, immediately preceding activities, and so forth.)

**Learning with intention to recall.** Another factor which is often mentioned is whether the material has been learned with the "intention" of being used at a certain time, that is, whether during the period of learning the learner includes in the present situation the future situation when the material will be needed. The degree of effort applied will be partially dependent upon whether that future date is near or remote. In learning today material we know we shall need a week hence with no further opportunity for practice, the incentive is greater than it would be if we were to need the material tomorrow.

As was pointed out in the preceding pages, the inability to recall or to perform an act once learned is no indication that it has been completely forgotten. The student often wonders what he has accomplished when he realizes that he cannot recall much of a single course which he has taken. Though a senior could not pass a creditable examination in one of his freshman subjects, he would need only a brief review to reëstablish what he had previously learned.

(Inability to recall may not be an indication of forgetting in the sense that the habit is lost, but may simply mean that, at the moment, the proper cues are not provided, or that something else interferes with the performance.) We have seen that inhibitions of this sort, in the form of persistent errors, interfere in learning by the

concentrated method. Recent events or chance associations may make recall at the time impossible, though at a later date the same material may be recalled without difficulty.

**Recognition.** (When recall is impossible, learning may be evidenced by the fact that the subject can identify the material.) If a list of nonsense syllables has been exposed and at a later period these syllables, interspersed among others, are again presented, the subject's learning may be tested by the number of correct identifications he makes.

We frequently find that we recall material which we cannot identify, while in other cases we can say, "I read that at such a place," or, "I know that is correct." In the latter case, we recall not only the particular item but also the various items connected with it, or our identification of the item is so definitely established that the habit is rendered certain; in the former case there is a minimum of recall.

**Teaching and learning.** In all the situations which have been described up to this point, the experimenter, after arranging the situation, figuratively and actually withdraws and leaves the subject to his own devices. All sorts of precautions have been used to prevent the subject's watching the experimenter and, from changes in the latter's facial expression, breathing, or movements, obtaining cues which would enable him to make correct responses. In order that the experimenter's bias may not influence the results, considerable energy has gone into the invention of automatic recording apparatus. In a word, the experimenter must be particularly self-effacing and, from the subject's point of view, nonexistent in the learning experiment.

In the problem of *teaching,* however, the experimenter

takes an active part. In any situation in which the experimenter makes any attempt to modify or to restrict the subject's activity, we may say that *teaching* is taking place.

In one series of experiments on both rats and humans, there was used a maze in which the subjects could be forced into the correct pathway by means of a mechanical device.[5] Varying numbers of "guided" trials, placed differently in the learning process, were given. With both rat and human subjects, substantially the same results were obtained. (Remembering was most effective where a small amount of guidance was inserted at the very beginning or near the end of the practice period.) Guidance in the middle of the practice period had little or no effect. In most teaching situations, the guidance is given verbally. What actually transpires in the classroom is not that the instructor teaches the student, but that he guides the student's activity by suggestions of subject matter which restricts his field of activity within the confines of the material which it is desired that he learn and attempts, by illustration and demonstration, to integrate the new with the old in the student's experience. The student himself must actively deal with material in order to learn.

## Practical Applications

In a comparison of the two kinds of courses or two methods of instruction in one course—a problem that frequently confronts the educational technician—different methods used in testing retention may give entirely different results. If the subjects are asked to recall the

[5] Carr, H. A., "Teaching and Learning," *Jour. Genet. Psych.*, 1930, Vol. XXXVII, pp. 189–219.

material of the course, the result will be one thing. If the recognition method is used, the type of item will be extremely important. Retention is greater, by the recognition method, for general principles than for detailed facts. If the examination for retention of the course materials concerns details, the results are about the same as for nonsense syllables; but if recognition of broader generalizations is required, the scores may be higher after a year or more without a similar course than they were immediately after taking it. Here again, we probably have the problem of overlearning. It is not that detailed facts are different from broad generalizations *per se*, but that the detailed facts have no application in everyday life and as a consequence exhibit no *ad interim* practice.

Measurements on grade-school children in May and in September after the summer vacation show that there are definite increases in intelligence test scores and in reading ability, but that in arithmetic, spelling, and so forth, which presumably are not practiced during the summer, there are decrements over the preceding spring.

The practical question which confronts educators is that of reducing to a minimum the formal instruction in skills and knowledge which have no application in everyday life.

### Questions for Review

1. What is the conclusion to be drawn from the work with the length of material compared with the number of repetitions required for learning?

2. What would you have to know before advising a person to use either the whole or the part method, or some modification of them, in learning any given performance?

3. Compare the advantages of concentrated and distributed repetitions in learning.

4. List some of the practices outlined in this chapter which you could use in rearranging your study habits so that they might become more efficient.

5. What general relationship exists between learning ability and age?

6. What are some of the important factors which determine the shape of the forgetting curve?

7. Contrast the two theories of forgetting outlined in this chapter.

8. What particular aspects of the recall situation facilitate retention? In what way may a knowledge of these factors be used in learning?

9. Compare the various methods of measuring retention.

10. What do experiments indicate regarding the effectiveness of teaching in learning? Make some practical applications of these principles.

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# SECTION IX. HIGHER TYPES OF MENTAL ACTIVITY



References to Student's Guide:

Exercise 86. The Multiple Choice Experiment
Exercise 87. Maier's Reasoning Problem
Exercise 88. The Use of Tools in Subhuman Primates (Motion Picture)
Exercise 89. Paper-and-Pencil Problems
Exercise 90. Cut-out Puzzle
Exercise 91. Peterson's Rational Learning Problem
Exercise 92. Class Demonstration in the Evolution of Concepts
Exercise 93. Hull's Method of Studying the Evolution of Concepts

CHAPTER XXV

# Problem Solving in Apes and Men

In the preceding chapter, we have laid the greatest emphasis upon routine learning. A great deal of what should be included under learning is a matter of the solution of new situations, in which we say that there is a greater demand made upon the intelligence of the individual in adapting himself to these problems. Man reasons out the solution of the problem, or he observes what somebody else does in the same situation and attempts to imitate him. Many times, the situation requires ingenuity. For example, if your car refuses to go and there is no one at hand to fix it for you, it is your problem to find a way out of your difficulty. It is also interesting to know to what extent lower animals can solve problems; many times, from their simple behavior we can learn how a human being attacks a problem.

**Learning by observation of another.** One of the early experiments on observational learning [1] was designed to determine whether one animal could profit by the behavior of another. The puzzle box was divided into two compartments. In one compartment, which was not provided with a mechanism for escape, an untrained cat was placed. Through the bars, it could see a trained cat, which was placed in the other compartment provided with the escape mechanism.

[1] Thorndike, E. L., "The Mental Life of Monkeys," *Psych. Rev. Mono. Sup.*, 1901, No. 15, p. 35.

After the untrained cat had been given several opportunities to see the trained cat escape, it was placed in the escape box; but it displayed no evidence of having profited by the other cat's behavior. Similar experiments with dogs and monkeys gave essentially the same results.

In another experiment,[2] two apes (orang-outangs) were observed with more positive results. One ape had learned to secure a piece of banana from a tube by pushing it out with a stick. After the second ape had seen the first secure the food several times, he was given the tube and stick. He proceeded at once to use the stick as a tool to get the banana, but the details of his behavior were unlike those of the other ape in that he pulled the fruit out instead of pushing it.

Both investigators were interested in the possibility of *imitation.* To imitate, the act itself should be copied; but in these and similar experiments it is generally found that the second animal does not actually copy the behavior of the first. What does occur is a more definite restricting of the range of activity to the crucial elements of the problem. It is therefore more appropriate to speak of this behavior as *learning by observation.*

The degree of observation will vary with different animals. Some can observe, if anything, only the general area of attack upon the problem, while higher animals can observe specific elements of the behavior pattern. In the experiments cited, the cats, dogs, and monkeys do not observe the behavior sufficiently accurately to make use of it. The ape's performance approximates such observation, but it is very inferior to what we might expect from a normal human subject.

[2] Haggerty, M. E., "Imitation in Monkeys," *Jour. Comp. Neur. & Psych.*, 1909, Vol. XIX, pp. 337–455.

**Nature of problem situations.** It is well to emphasize the fact that a problem and its solution involve the total situation, including the surroundings which may play a part in its solution. The German psychologists have named this factor *Gestalt,* which is best translated as *configuration.* By this we mean that the subject does not discriminate discrete elements in the situation, but each so-called element bears a relation to the whole. We find in our own behavior that we deal with things first in a rather general way and then more and more in a specific manner.

You may have had the experience, when driving a car for the first time, of having something go wrong and raising the hood to discover what needed adjusting. If you had never looked beneath a hood before, you were doubtless nonplused to see so little with which to tamper. To the skilled mechanic, there are innumerable specific parts: He may instantly see that the generator is out of order, that a spark plug is fouled, or that a connection in the ignition system is broken. The ability of apes to cope with problems and their illustration of this principle of configuration is interestingly shown by a series of experiments.[3]

**Solutions of simple problems.** As one of the first experiments, a basket of fruit was hung by a rope from the top of the cage. The other end of the rope, in the form of a loop, was slipped over the stump of a limb of a tree. The ape first attempted to reach the fruit by jumping. Then he climbed the tree and pulled vigorously on the rope, jerking the basket to the top of the cage and breaking the rope. Thereafter, pulling on the rope continued to be his method of obtaining the fruit.

[3] Köhler, W., *Mentality of Apes,* New York, Harcourt, Brace and Company, 1925.

In another experiment, fruit was placed outside the cage out of arm's reach of the ape, and a stick with which the fruit could be raked in was provided. If the stick was placed between the ape and the fruit, or within easy reach, he had no difficulty in utilizing it for the purpose. If, however, the stick was out of sight behind him on the opposite side of the cage, he failed to make the connection between the fruit and the stick as a tool for obtaining it.

With further experience, a stick, regardless where placed, was quickly appropriated. On one occasion when no stick was to be found, one ape suddenly left the side of the cage, ran into her sleeping quarters, and returned with a piece of a blanket with which she whipped the fruit into the cage.

**Interpretation of apes' behavior.** These experiments illustrate some of the limitations as well as the possibilities of the ape's development in dealing with problem situations. In the first experiment, the ape began by reacting directly to the fruit by jumping. Then, he climbed the tree, which took him higher, but again too far from the fruit. Pulling the rope made it possible for him to see the relation between the rope and the fruit, and vigorous activity brought the desired result. The more indirect method, which would have been employed by a human subject, namely, slipping the loop off the tree, was never observed.

In the second experiment, the ape was unable at first to see the relationship between a stick behind him and the fruit. When he was facing the stick, he could not see the fruit; when facing the fruit, he could not see the stick. When the stick was between him and the fruit, it was included in his "configuration." He was able, however, to develop these relationships so that a stick

anywhere became a tool and even other objects could be substituted for it.

**The "building" experiment.** In another experiment, the fruit was hung in the center of the cage too high for the ape to reach it from the ground. At one side of the cage was a box sufficiently high that, if it were placed under the fruit, it would bring the ape within easy reach of the fruit. After reaching and jumping for some time, the ape climbed upon the box in its original position. Sometimes he would climb on the box and then run to the center of the cage as if he expected in so doing to maintain the desired height. Finally, he tumbled the box to the center of the cage and thus reached the fruit.

After this procedure had been learned, the fruit was placed so high that two or even four boxes, one on top of the other, were necessary. The need of building this platform was quickly grasped, but the ape showed little ability at first to make the proper structure. He would place the second box with the open side up, and would climb into it without success in his project; or he would not place the boxes substantially, and the whole pile would tumble down. After considerable labor, the task was satisfactorily performed. The whole performance seems to have been of the trial-and-error type, but involved a certain amount of *observation* in advance of what is observed in the lower animals (Figure 71).

**Experiments with feeble-minded and normal children.** Miss Gorsuch [4] has repeated Köhler's stick and building experiments with a group of feeble-minded boys of approximately 10 years of age who were rated by psychological tests as possessing the general ability corresponding to that of normal children 3 to 4 years old. As

[4] Not published.

Figure 71.—The Achievement of a Four-Story Structure. (*Köhler.*)

a preliminary training, for several days these children were encouraged to play with brilliantly colored balls. They were then taken to the same room, one at a time, and left with no intimation of what was expected of them. In one experiment the ball was placed on a cabinet out of reach, and the only movable object in the room was a stick. The subject was observed through a one-way screen.

The boys differed in one respect from the apes in that they frequently talked. "I wish I had that ball." "I wish Miss Gorsuch would come back." The following report on one boy is typical: When he first discovered the ball, he reached for it, attempted to get it by jumping, backed to the opposite wall, ran to the cabinet, and climbed into the window, which was too far away. Finally, while sitting in the window, he looked at the stick with which he had just been playing, and then looked at the ball. He promptly jumped down and, with the stick, knocked the ball off the cabinet.

The normal children, 3 to 4 years old, differed little in their behavior from the feeble-minded, except that they displayed wide individual differences in home training and were physically less strenuous. The effect of home training is illustrated by one youngster who failed to get the ball when alone but, when Miss Gorsuch was in the room, asked for it and was told to get it. He promptly picked up the stick and knocked the ball off the cabinet.

**The jointed stick experiment.** When he had learned to get fruit from outside the cage by raking it in with a stick, one of Köhler's apes was given two sticks which could be fitted together to make one long stick, and the fruit was placed where it was too far away to be reached with one stick. For over an hour he made various attempts to get the fruit, using one stick at a time.

Finally, he retired to a box in another part of the cage. In a few minutes he began to play with the sticks, and during this manipulation he happened to find himself holding one stick in each hand in such a way that they were in a straight line. He pushed the smaller one a little way into the larger one, jumped up and ran to the bars of the cage, to which he had up to now half turned his back. He began to draw in the banana. Then, the sticks fell apart, whereupon he connected them again. The next day, only a short time was required for him to again utilize the double stick (Figure 72).

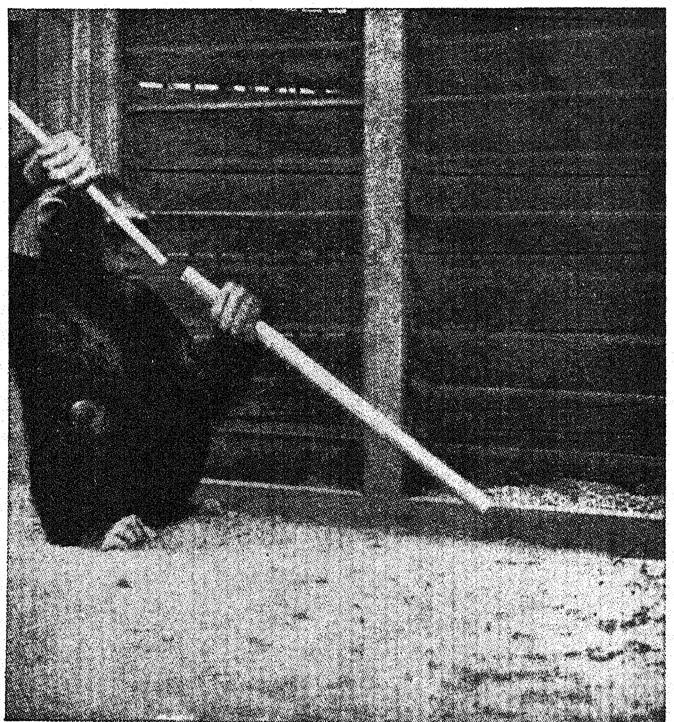

**Figure 72.—Sultan Making a Double Stick.** (*Köhler.*)

The question of "insight." The experiments with apes have led to frequent discussions of the possibility that their learning is by insight, as contrasted with the purely trial-and-error learning of the rat or the cat. While these animals, when placed in the puzzle box or maze, perform a great number of useless acts and finally hit upon the correct act as if by chance, there are many instances in which the ape observes the situation and selects the correct act with little or no random behavior. The use of the jointed stick is a very good example of this type of response. The futile attempts with each short stick resembled very much the random behavior of the cats. So also did the manipulation of the sticks after the fruit had apparently been abandoned. But the abrupt turning to make use of the longer stick obtained when the two sticks had been combined indicated a new factor. This behavior is an indication of "insight" or the intelligent solution of the problem.

In order to understand such "insight" behavior, it is necessary to examine more carefully the antecedent behavior. The ape had been working to get the fruit, but all his efforts had failed. As he sat playing with the sticks, the unattained food was near-by, just out of reach. He had been using sticks that were too short. Doubtless, this immediately preceding activity was still effective, and a posture with reference to the food was not wholly lacking.

When the sticks fitted together, they served as a stimulus for return to the fruit, for the preceding activity had already conditioned the ape to the "long stick" response. The outstanding feature of the experiment, then, is not that this is a new type of behavior, but that it is a more complicated situation which the ape can master by the same methods that the cat uses in the simpler situations.

It is "intelligent" behavior in the sense that it involves more complex behavior.

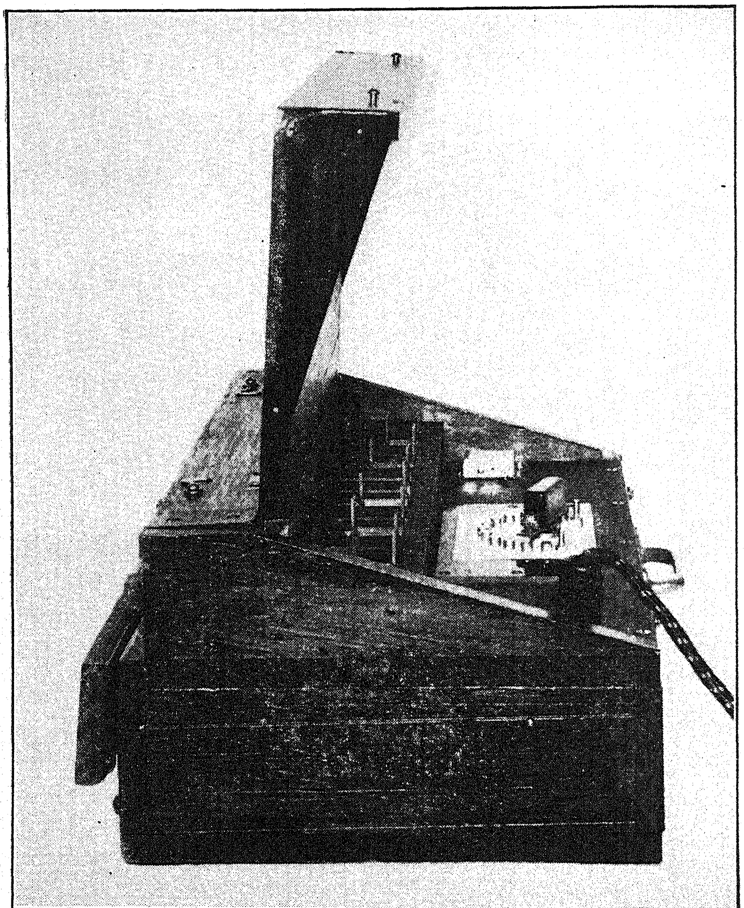

**Figure 73.—The Yerkes Multiple Choice Apparatus for Human Subjects.** (*Modified at Ohio State University.*)

**The "multiple choice" experiment.** Yerkes devised for animal and human subjects an experiment in which the task was to learn which of several keys was the cor-

rect one. The problem was set up somewhat as follows. A box was constructed with a row of keys hidden from the subject. Any number of these keys could be pushed out to the view of the subject, and any one of them could be connected with an electric buzzer (Figure 73). Let us suppose that keys 1, 2, and 3 are exposed, and that 1 is connected with the buzzer. The subject may press them in any order, but pressing 1 sounds the buzzer (or provides food, in the case of animal subjects). In the next trial, keys 3, 4, and 5 may be exposed and 3 connected with the buzzer. In this series, the first key on the left is always the correct key. The problem is to determine how quickly the subject will learn, or catch on, that it is always the first key. Then the experimenter sets up a new series, in which it is the last key, or the middle key, that is correct.

Yerkes[5] used two monkeys and one ape (orang-outang) as subjects. An interesting feature of his results is that the monkeys learned the first series more readily than the ape and displayed normal learning curves. For more than two hundred trials, the ape seemed to profit little by repeated tests (Figure 74). Then his curve dropped rapidly. When a new series was given, the monkeys were unable to profit by the preceding series, while the ape "caught on" rather quickly. This is another example of the superiority of the ape in the use of "insight," or in the ability to deal with more complicated situations.

**Multiple choice with human subjects.** With human subjects, the situation is different in some respects. The subject may be instructed simply to "find the key that sounds the buzzer." But he already knows, or soon sur-

[5] Yerkes, R. M., "The Mental Life of Monkeys and Apes," *Behav. Mono.*, 1916, Vol. III, pp. 1–145.

mises, that there is a plan to the series, and he sets out to discover the plan. He also verbalizes either silently or aloud. Though they show great individual difference in the time required to hit upon the plan and in the ability to get the more complicated series, the human subjects are considerably superior to the apes.

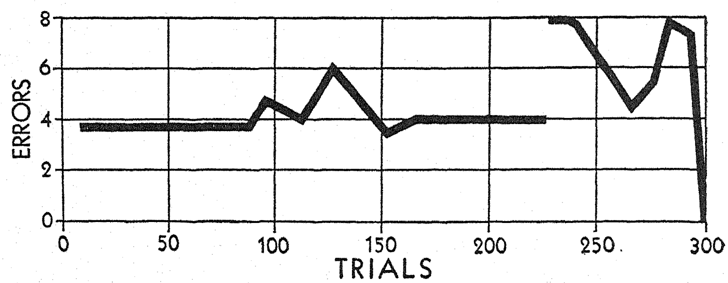


**Figure 74.—Curve Showing the Progress Made by an Ape Toward Mastery of a Multiple Choice Problem.** (*Yerkes.*)

One interesting feature of the human performance is that often the manipulation of the keys interferes with the solution: another subject observing the performance will hit upon the plan more quickly than the manipulator. Evidently, the human subject acquires the solution more readily when it is not interfered with by his manipulating the keys.

Puzzles with human subjects. In place of the box used with animals, small, wire "Chinese puzzles" are frequently used with human subjects. These present many of the features of the animal experiments and, at the same time, offer greater difficulty and variety. Usually the subject displays a great deal of the behavior of the cat in the puzzle box; his method is principally trial-and-error. As he manipulates the puzzle, for example, that of two bent nails looped together (Figure 75), there is little

evidence of a plan in his performance. Finally, the nails come apart, but he is unable to say just how. On the second trial, his behavior is much the same, but usually less time is required. Also, the movements become more localized. In most cases, the repeated solution of this puzzle displays the typical trial-and-error curve. If, when the first puzzle has been learned, a second similar puzzle is tried, the first movements are very much the same, but the solution is hit upon more quickly. In the majority of cases a sudden drop in the curve is paralleled by the report of the subject that he "saw through" the problem.

**Verbalizing a solution.** One of the interesting features of these puzzle experiments is that they give less opportunity for definite verbalizing than the multiple choice experiment. The subject may say, "Turn it this way," but he has no definite names for the parts and movements. The bent nails were given to students in the laboratory with the instructions to let them lie upon the table while they worked out the proper solution. When they were sure of the solution, they were to pick up the nails and take them apart. The time and method required to take them apart after this preliminary study were about the same as with no study. In two cases, the students made drawings of the nails and lettered every possible section, and then worked out the solution in verbal terms. When they picked up the nails, they were able to take them apart with very little useless movement, though some manipulation was still required.

**Behavior in natural and experimental situations.** It is interesting to note that under experimental conditions animals frequently exhibit a high level of performance which is probably never attained in their natural habitat. It is reported that monkeys will throw sticks, stones, and

cocoanuts at approaching animals, but there is no evidence that they ever construct tools of any kind. It seems probable that they are physically so well adapted for getting along in their natural habitat that it is not sufficiently important for them to develop new modes of adjustment, particularly when these would be relatively complicated, such as making a jointed stick or discovering the relationship among several relatively unrelated acts.

In the laboratory, the field of activity is restricted by the experimental situation. In order to get food, the animal must do what the experimenter has set up for him to do. Under these conditions, if both the experimenter and the animal are sufficiently persevering, solutions are hit upon that may employ the maximum of the animal's neurological and skeletal equipment. Just as in the case of man, we do not yet know fully to what extent the apes, monkeys, and the lower animals may go in the use of the equipment they possess. More patient experimenting continues to uncover still greater possibilities.

Recently it has been shown that some of the smaller monkeys can make use of tools to an extent that was heretofore believed possible only for the higher apes. Nevertheless, it has been necessary to perform over two hundred experiments to demonstrate this possibility. One cebus monkey has learned not only to use a stick to draw in food placed beyond his reach, but also to rake in a longer stick with a shorter one when the shorter is not long enough to reach the food. He then uses the longer stick for this purpose. If a stick is not available, he will use anything that will serve as a substitute, such as an old bag, a newspaper, and, in one instance, the fronds which he broke off a potted fern. If no implement is in sight, he will hunt for one, and will use the first he

finds; if it is not adequate for obtaining the food, he will use it to get another implement that is out of reach.

This performance is undoubtedly more difficult for this monkey than the description makes it appear to be. Though he is able to make use of the long stick, for example, his manipulation is considerably uncoördinated and clumsy like that of a human infant. His discovery of the correct solution of problems, even when he possesses tool-using hands, is slow. It is only with great difficulty that he hits upon such acts at all.

**Human development of tool using.** When we turn to the history of human civilization, we find that the situation regarding the learning of the use of tools in man is much the same as we find among the apes and monkeys, except, of course, that man's superior skeletal structure and highly developed brain have made possible a much greater advance. However, this advance has been a long and tedious process, as viewed from our standpoint. Man undoubtedly possessed a sufficiently developed neuromuscular system to permit the highly coördinated use of tools and the solution of problems long before much progress was made in this direction. This slow development of more complex behavior seems to have been due, as in the case of the lower animals today, to the fact that living conditions did not demand invention of new modes of meeting the physical and social conditions.

It is generally accepted as a fact that man has been on the American continent for ten thousand years; yet, previous to the arrival of the white man, he never advanced very far beyond the stone age. The making of flint arrowheads and spearheads, the fabrication of blankets, baskets, and pottery, together with a crude art and archi-

tecture, marked practically his total progress. In other areas, man has existed for a much longer time. However, it is only in the last few thousand years that the more important discoveries or inventions, which distinguish man from the lower animals, were made. This slow progress was not due alone to primitive man's inferiority; both the physical need and the social incentive were lacking.

### Questions for Review

1. In terms of the behavior of the learner, what does learning by imitation involve? What are some of the animals in which learning by observation has been experimentally demonstrated?

2. Cite some examples from your own experience in which your behavior was a response to a total stimulating pattern at first and at some later time a response to parts of that pattern.

3. What is the interpretation of the behavior of the apes in the two experiments involving the obtaining of food placed out of reach?

4. What are the similarities and differences between the behavior of apes and that of feeble-minded and normal children in situations in which a lure is placed out of reach?

5. What is the aspect of problem-solving behavior which gives rise to the concept of "insight"? Is this word to be used as a noun or an adjective?

6. What is the chief advantage of using the multiple choice technique over the use of the maze in making comparisons between human and infrahuman learning?

7. In what ways does the behavior of the adult human differ from that of the ape in the multiple choice situation?

8. What are the chief characteristics of human problem-solving behavior?

9. In what respects may man be said to possess an advantage over the lower forms in so far as his problem-solving behavior is concerned?

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## CHAPTER XXVI

# Thinking

In the present chapter we shall see that learning, as has already been shown, many times involves what might be called *thinking* and in many instances what we shall identify as *reasoning*. We usually consider problem solving as reasoning, though in many cases the solution is arrived at without any clear indications of thinking. In other words, there are two methods by which a solution may be secured. We may term these the *direct* and the *indirect* methods of approach.

**Direct and indirect reactions to the situation.** In the previous experiments in which the animal was confined in a puzzle box, we have seen that he made random movements which eventually led to the successful act. In this case, he was reacting *directly* to the situation presented. In many cases of solving problems, the human subject behaves in much the same way. If a puzzle such as that illustrated in Figure 75 is presented to the

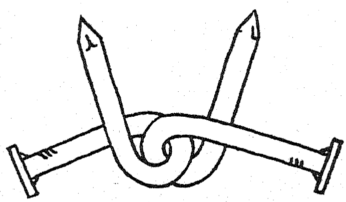

Figure 75.—The Bent-Nail Puzzle.

subject and he is requested to take the two nails apart in the shortest possible time, it will be noted that he makes numerous movements of a trial-and-error character. He twists the nails in one direction and then in another until, finally, they would come apart if it were not for the heads, which catch in the loops. Even this fact does not seem to give him the cue that, if he reverses the movement, the same position will be secured with the points to the loops, and that, therefore, they can easily slip apart. His behavior, in other words, is very much the same as that of the cat in the puzzle box. His method has been direct trial-and-error, and his reactions are principally explicit.

Let us assume that a similar puzzle is presented with the instruction that the subject is to solve it without manipulation, and that when he is satisfied that he has the proper solution, he may then perform it. He may, or may not, be able to reach the proper solution in this way. But suppose that he does. In this case, *he has thought out the solution.* Something has been going on which has not been explicit. His methods, in other words, have been presumably trial-and-error of an *indirect* sort. He has been dealing with the same object indirectly, while in the previous case he was dealing with it directly. One of the possibilities would be that the subject has reacted to the puzzle by the use of language, that is, that he has talked to himself.

**Language in problem solving.** An interesting example of the value of language in this sort of situation is given by the results that the writer has obtained with the nail puzzle. A group of students were confronted with the same puzzle individually and asked not to touch it until they were certain of their solution. In every case but two, considerable manipulation was necessary before the

subject could take the nails apart even after 15 or 20 minutes of study. In the two cases, the restriction was circumvented by the students' making drawings of the puzzle, lettering the essential parts, and then writing the solution. After several attempts by this method, each was able to pick up the puzzle and take it apart without any evident useless moves. Language was, therefore, an effective tool in this situation.

Another example of thinking, with language as the tool, is shown in a little girl's behavior in the solution of a problem. On the deck of a ferryboat was a rack containing several pails filled with water. The little girl asked her father what the water was for, and he suggested that she answer that herself. This she did in the following oral manner: "The water is put there to drink. No, that fountain over there has drinking water; this is dirty and has no ice. It's to put fish in. The pails aren't big enough." (She had seen only large fish during the summer.) "It's for the horses to drink. There aren't any horses on this boat. It's for the engine. The engine is down in the bottom of the boat where there's lots of water. They use it to scrub the floor." This seemed to satisfy the little girl, though the water was really for use in case of fire. Two features in reasoning are demonstrated by both of these illustrations:

1. The solution of a problem involves a number of trials before the proper reaction is reached.

2. Language may be used as an effective tool in the indirect dealing with the problem.

**Experiments on implicit verbal reactions.** We have assumed in the case of solving the mechanical puzzle that the subject employed language as a tool. Several investigators have attempted to demonstrate the presence of

laryngeal movements during the process of thinking or of remembering implicitly. Lashley, who recorded the movements of the tongue in two directions by means of a delicate instrument, required his subjects to read a sentence aloud and immediately afterward read the same sentence silently. The movements recorded corresponded very closely under these conditions, except that in the second case they were smaller.

When, however, the subject read the sentence first aloud, and then turned to other types of work, the recorded movements during a later reading of the same sentence did not correspond particularly well with those during the earlier oral reading. Still, there were movements evident. The non-correspondence of these movements is what might be expected when we consider that the entire vocal apparatus is very complex and that we rarely make identical movements in speaking the same word. The essential feature is that movements existed at all.

Other investigators have found divergent results. The mere failure to detect movements in the vocal apparatus would not necessarily prove that the thinking was non-verbal. The instruments may not be sufficiently delicate to record slight contractions. However, it would be rash to assume that all thinking is in terms of language. It is an old saying that the reason the animal does not talk is that he has nothing to say, which implies that his thought processes are not sufficiently developed. Watson has made the radical statement that the dog cannot think because he has not sufficiently developed vocal apparatus. Both views are extreme. It would be nearer the truth to say that language is an important factor in thinking, because it is a highly complex function and makes possible a variety of forms of reaction that other-

wise would not exist. Instead of making an overt movement, we may substitute a word. We may *think* of walking downstairs in terms of words as a substitute for the actual process of walking downstairs.

**Other forms of symbolic behavior.** We may use as a substitute for overt behavior not only words, as symbols, but many other types of implicit responses which may symbolize for us the reactions embodied in the thinking process. The deaf-mute has a language in the form of movements of the fingers and the arms. Every individual has similar movements of a non-verbal type symbolizing more direct responses. Like the implicit language response, these bodily movements become a means of self-stimulation. One may observe these movements of hands, arms, face, and other parts of the body in a friend who is very much interested in a performance at the theater or in a story that someone is relating.

If this individual is placed before the Yerkes multiple choice box and instructed to solve the problem set up, he may succeed without language and without making many overt responses by a process of implicit reaction of the hand and arm with reference to the keys. In this case, the eye-hand coördination is substituted implicitly for the verbal reaction, and the problem is solved in these terms.

If you ask a man how to perform a particular complex act, you may find that he is unable to describe it without going through the actual movements required. He has evidently learned the act in non-verbal terms and can recall it only in those terms. He can describe it only as he actually performs it.

**Eye movements in thinking.** One convenient type of response for objective study is eye movements. If a watch is held opposite one ear and then the other, and

the subject is asked to listen to the tick, it will be observed that the eyes turn in the direction of the watch. In recent experiments the movements of the eye have been photographed: the head is held in a fixed position, and the camera is set up with a moving film which will record the position of a white spot fixed upon the cornea of the eye.

When the subject is asked to imagine a train passing across the landscape, the eye movements are generally in a horizontal direction. When he is asked to imagine a bird flying across the field, the movements are horizontal, but zigzag in the vertical plane. If he imagines an airplane soaring overhead, there is a tendency for the eyes to turn upward. Such movements, and the combinations of movements of various members of the body, comprise the implicit reactions that are involved in thinking.

For many years there was a controversy among philosophers and psychologists as to whether these implicit movements were absolutely necessary for the so-called mental processes of thinking and imagining. If one imagines a red cube or the voice of a friend, there seems to be in the experience nothing that is not visual in the first case and nothing that is not auditory in the second. The processes seem to be purely sensory and central, with no absolutely necessary involvement of implicit muscular reaction.

There have recently been developed instruments based on the vacuum tube used as an amplifier which demonstrate that even in these conditions there are muscular reactions of an implicit type. They are so weak, however, that any mechanical method of recording them is hopelessly too crude.

By means of a technique known as *progressive relaxa-*

*tion,*[1] it is possible to train a subject to relax his muscles on command more completely than most people ever are able to do. A training of this kind is necessary for the experiments with the delicate electrical apparatus now employed because, even when the untrained subject reports that he is comfortably relaxed, the apparatus shows continuous evidence of comparatively intense nerve and muscle activity. To ask a subject of this kind to imagine throwing a ball three times with the right arm introduces nothing new into the already complicated record. But with a sufficiently relaxed subject there is a definite increase in the amplitude of the record corresponding to this instruction, even though the subject reports that there was absolutely no movement of the arm. The electrical recording apparatus is simply more sensitive than the subject's own sense organs.

Experiments of this type indicate that the common notion that thinking and imagining are brain processes alone—that the activity is entirely in the central nervous system—is not true.

**Abbreviated reactions.** The implicit responses need not be complete. There is always the tendency in thinking, as in other behavior, to reduce the movement to the minimum, whether it is implicit or explicit, very much as was shown by the behavior of animals in the puzzle box experiments. We see the same process at work in the development of written language. The earliest writing was in the form of pictures which were fair representations of the objects and situations. These were gradually reduced to symbols that show only slight resemblance to the originals.

[1] Jacobson, Edmund, *Progressive Relaxation,* University of Chicago Press, 1929, especially pp. 165–189. See also "Electro-physiology of Mental Activities," *Amer. Jour. Psychol.,* 1932, Vol. XLIV, 677–694.

These characteristics may be found in the Chinese symbols. "House" is represented by the upper portion of Figure 76 *A*; "man" by the two lower strokes of the left part of *B*; and "a man going forward" by the addition of the third stroke. Similar abbreviations are recognizable in our own language in everyday use, both oral and written, such as the careless slurring of the syllables and the omission of endings.


Figure 76.—Chinese Characters Which Possess Only Slight Resemblance to the Objects or Situations They Represent.

Implicit reactions may be still further reduced, for, in self-stimulation, whether in the form of "talking to oneself" or in the form of other bodily movements, the processes of stimulation and response are easier. The subject is more nearly adjusted to the problem in hand than is another person who has not the same, and never can have exactly the same, conditions for setting up the situation. The various factors contributing to his adjustment are different. Thus, the slight movement of an incomplete vocal response may be adequate for thinking.

**Development of abstracting and generalizing.** A young child may be presented with a small, furry animal and at the same time hear the word *kitty*. With frequent repetitions of this situation, the word *kitty* becomes associated with this animal. If another small, furry animal is presented, it, too, will be called *kitty*.

Further experience with cats, rabbits, and dogs of various sizes and colors results in a distinction among these. Some animals are cats, others are rabbits, and still others are dogs. Somehow, those characteristics which are the attributes of a cat have been *abstracted*.

The child also *generalizes* in his application of this abstraction to all cats. In the same manner, we develop a generalized abstraction, or concept, of triangularity and sphericity. We are confronted with triangles of many sizes and shapes. Marbles, balls, and globes are of various sizes and colors. From these we learn to abstract "triangle" as three-sided or three-angled, and "sphere" as "round solid." We generalize from these situations when we apply this concept to other objects that possess in greater or lesser degree the abstracted characteristic.

In a similar fashion we form such generalized abstractions of peace, honor, and virtue. That these are the result of meeting with certain characteristics in many situations can be shown by examining what one means by the term used. Usually, when a person is questioned as to what he means by "virtue," he will reply by giving an example. If he is further pressed, he will give several examples. Honor, for some persons, is expressed only in personal courage in defense of one's country, while for others it is a matter of veracity, and stealing and other criminal acts might be defensible. In other words, the generalization must be based upon the situations that the individual has met.

The origin of generalized abstractions is displayed in many Chinese characters. Thus, the word for *peace* is "one woman in a house" (Figure 76 *A*); *virtue* (*B*) is "a man taking a step forward with his whole body according to his heart"—that is, behavior in complete accord with his conscience; *good* (*C*) is "a woman and her

son." Each speaks eloquently the Chinese development of these particular generalizations.

**Experiments in abstracting and generalizing.** The following is a good example of an experimental study of the development of abstracting and generalizing.[2] For his material, the investigator selected 144 Chinese characters (Figure 77). These were printed on cards and the cards arranged in 12 packs. One character of each pack contained the same characteristic, thus making 12 hidden characteristics, each in 12 different Chinese characters of various degrees of complexity.

The cards of one pack were placed in an exposure apparatus and shown to the subject at the rate of 1 character every 5 seconds. Two and one-half seconds after the beginning of an exposure, the experimenter pronounced the nonsense word corresponding to the character. The subject was instructed to learn the word of each character and try to anticipate the instructor in pronouncing it. When the first pack had been learned, the second pack was exposed. The hidden characteristics and names were the same as in the preceding list, but the total characters were different. When this had been learned, the third pack was used, and so on for the first 6 packs. In every case the hidden characteristic and name were the same. The subject, however, was not informed of this fact or of the purpose of the experiment.

After the first 6 packs had been learned, the other 6 were used to test the subject's development of the generalized abstraction. The number of characters that he could name correctly was taken as a measure of this development. The number of repetitions required before he could anticipate the experimenter in naming the

[2] Hull, C. L., "Quantitative Aspects of the Evolution of Concepts," *Psych. Mono.*, 1920, Vol. XXVIII, pp. 1–86.

characters in the learning series was also taken as a measure of the evolution of the generalized abstraction.

Figure 77.—Chinese Characters Used as Material for Studying the Forming of Habits as Generalized Responses to Abstracted Stimuli. (*Hull.*)

Efficiency in development of generalized abstraction. Several problems arose out of the above experiment. The first one that the experimenter attempts to solve is whether, in evolving a new generalization, it is easier to proceed from the simple to the complex or from the complex to the simple. It is a general maxim of education that we should begin with simpler forms and work up to the more complex. In order to test this hypothesis, half of the material was arranged in the order of simple to complex and the other half in the order of complex to simple.

The results show that, in the evolution of such generalized abstractions as were here involved, simple experiences are more efficient than complex ones, regardless of whether they occur at the beginning or the end of the

process of evolution, but that the simple-to-complex order is no more efficient than the complex-to-simple order if we neglect the time necessary to master each character individually. It would seem, therefore, that the simple experiences are important wherever they occur in the series.

**Isolated versus hidden element.** A second problem in the development of generalized abstraction is whether the individual is assisted by having the hidden character isolated for him. Is it more efficient to spend a given amount of time in learning the reaction to the abstract characteristic as yet not experienced in its concrete setting, or to spend the same amount of time in perfecting reactions to a series of concrete situations? The theory has been that, to have functional value, the abstraction must be evolved from the concrete by each individual himself. Some situations produce pain, and others bring satisfaction. The child must learn that stoves are hot and that animals bite, by meeting these situations.

This problem was attacked by the presentation of series of Chinese characters as in the previous experiment, except that in place of half of the characters with their hidden characteristic, this characteristic, or element, was presented alone. That is, the first 6 characters remained the same, but only the common element was used in the last 6. When these had been learned in the manner of the previous experiment, the 6 test packs were used to determine the relative functional efficiency of the two methods.

(Of the two methods compared, there was no clear-cut advantage in either so far as generalized abstraction is concerned. However, the ability to define the hidden element was greater for those elements that had been given outright. If, however, the hidden elements were

given alternately (that is, first the common element alone, then the total character, and so on), the latter method was found to be distinctly more efficient.)

Several questions regarding the evolution of generalized abstractions were also investigated by this method. Hull has demonstrated quite conclusively that the whole problem of the "higher thought processes" can be investigated in the laboratory as effectively as we have investigated the simpler processes of learning. A great proportion of our educational endeavor is for the purpose of developing abstractions, general principles of thought and action, and it is exceedingly important that we know more definitely what are the best methods of evolving these principles.

**Steps in reasoning.** (Reasoning usually occurs in a complicated situation which is of some significance to the individual and which calls forth some formulation of reaction which is not easily arrived at.) The complete act of reasoning includes several steps. Pillsbury uses as an illustration the dilemma of two canoeists who desired to reach a certain point in a given time. At some stage of the trip, miles from any habitation, they discovered that there was water in the bottom of the canoe. Going ashore, and tipping over the canoe, they discovered that the canvas had been cut. As they were in the wilderness, miles from any aid, the problem present was how to continue their journey. One of them realized that in the absence of the usual mending materials—namely, glue and canvas—pitch and a piece of a handkerchief would be a temporary solution of their problem. This point would mark the end of the reasoning process.

We might carry the illustration a little farther and assume that the incident followed this course: Upon the discovery of the rent in the canoe, one of the canoeists

recalled having seen the canoe mended by the application of marine glue, a piece of canvas, and a hot iron. He realized that this method was out of the question. He might sew the canvas, but this also was discarded for obvious reasons. As he walked about indulging in many useless movements, he got his hand covered with pitch from a balsam tree and, while pondering his problem, wiped his hand on his handkerchief. He observed that the handkerchief stuck to his hands. Balsam pitch on a piece of fabric of this character would make a temporary patch on the canoe. This, then, was the solution of his problem.

We may identify in this process the following steps:

1. Interference with the activity of the moment. Water in the canoe was a cue that something was wrong. In most cases of reasoning, there is a blocking of present activities or a dilemma which cannot be avoided.

2. The problem presents itself. The discovery of the tear in the canoe presents the problem which is to be solved.

3. A number of suggestions arise. Some of these are in terms of verbal reactions to the situation and recall of past events. One by one, these are discarded or dropped out of the picture because they fail to meet the present emergency.

4. A reaction which satisfies the present situation is established. This is the solution, and hence the end of the problem.

The whole process has been one of the blocking of present activity and of trial-and-error reactions with the ultimate selection of the response which satisfies the present conditions. This is much the same type of behavior that we have seen to exist in the case of the cat

in the puzzle box, except that abbreviated, or symbolic, reactions were more probable in the present case.

**Essentials of good reasoning.** What constitutes a good reasoner is dependent upon several factors, namely: previous experience, activity, and discrimination. Our canoeist possessed certain knowledge regarding the patching of a canoe. He also possessed other knowledge regarding various materials and various methods of using these materials. Furthermore, this knowledge was readily available. He recalled many things which were possible solutions or possible tools for the emergency. He also had the ability to make accurate discriminations: that a property of glue is its adhesive quality; that canvas is a fabric, and that a handkerchief is a similar fabric which could be substituted. He was able, therefore, to select from many possible reactions those part reactions that are applicable to his present situation and to combine them into the newly required pattern.

We might assume that his companion lacked this so-called "reasoning" ability. He was able to recall seeing a canoe repaired in the factory by the usual method, but he was unable to see the similarity between this process and the process which was originated by his companion.

A similar situation is presented when a teacher assigns an original problem in geometry. The requisite data have been acquired by all the students, but only a few are able to effect a reorganization of these data to meet the requirements of the present problem. Some do not recall the data previously learned, while others are unable to select those elements which are pertinent to the present problem.

**Essentials of reasoning are abstracting and generalizing.** In each step of reasoning as above described, the

individual is dependent upon his ability to abstract the common elements. He has met such situations—canvas, cloth, and handkerchief—but unless he has abstracted the common element, fabric, his ability to recall that canvas is used in mending canoes will be of little value in this emergency. Furthermore, abstracting the common element is not all. He must be able to generalize, to apply the abstracted element to other situations. We say that he has the ability to discriminate and to apply previous experience to a new situation. Reasoning, then, is the application of old experience to a new situation.

**Interference of "direction" habits.** One important difficulty in the solution of a problem is that we persist in attacking the problem always from the same angle. If we are attempting to repair an automobile and need to loosen a bolt which is stuck fast, we persist in trying to turn it until we have either broken the bolt or the tool or seriously injured our hands. We behave in much the same way as the ape when he secured the food by breaking the rope. A simple experiment will illustrate this principle. In Figure 78 are nine dots. You are required to draw, without raising your pencil, four straight

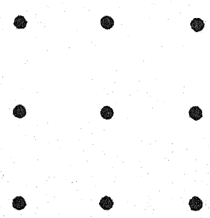

**Figure 78.**

lines which will pass through all nine dots. Make as many attempts at this solution as you choose. In all probability you will find that in every case you maintain

one specific attitude toward the problem. You will probably confine all of your lines to the area represented by the nine dots. It is only when you break this habit, which we may call a "direction" habit, and extend your lines beyond the area of the dots that you succeed in the solution.

When a rat is released in a maze, it may enter the same blind alley repeatedly in spite of the fact that doing so does not bring a satisfactory result. Human subjects in a maze behave in much the same way. In spite of the fact that we have tried one method and it does not work, we insist that it ought to work and hence we repeat the act again and again. In what we call "reasoning," we behave in the same manner. In spite of the fact that one attempted solution does not work, we fail to vary our method of attack and take a new slant on the problem. One factor in good reasoning, therefore, is the ability to shift one's methods and avoid "direction" habits.[3]

Creative thinking not a new type. There is a widespread belief that, while reasoning may be a process of putting together bits of knowledge and experience to make a new pattern or to find a solution to a new problem, some individuals, at least, are capable of *creating* something entirely new. Let us examine some of the possibilities in various fields where we might find the original thinker developing something new.

The inventor of a new machine must know the principles of dynamics in so far as they apply to his particular problem. He is perhaps familiar with machines of a similar character. But none of these meets the peculiar requirements. If there is one in existence that

[3] Maier, Norman R. F., "An Aspect of Human Reasoning," *Brit. Jour. Psych.*, 1933, Vol. XXIV, pp. 144–155.

can be adapted, the labor involved in the adaptation requires less effort, and it is therefore usually employed. The first automobiles, for example, were horseless carriages in fact as well as in name.

It may be, however, that his problem will not permit the adaptation of a similar machine. He may be inventing the first sewing machine. He has observed that it takes a long time to sew a seam by hand, and that a machine might do it more quickly and easily. An awl mechanically operated would carry the thread through the cloth, but withdrawal of the awl would withdraw the thread also. Something must hold the thread. Another thread could be slipped through the loop on the other side. Finally, the shuttle is hit upon. Step by step the problem is solved, but in every case known principles have been applied. The application of old experiences to a new situation, or generalizing abstraction, has been the rule.

The new disease epidemic baffles the medical profession. There are symptoms well known in other diseases, but this malady fails to yield to any known treatment. The disease may be due to a new bacillus or to some other cause. One investigator sets himself the task of discovering the cause of the disease. Whatever his method, he will be dependent upon what is already known regarding the nature of the human organism and its ills, plus new discoveries that he makes in the course of his investigation. It may be that he "gets an idea" as he works. This merely means that bits of evidence have accumulated and are formulated into a new pattern of reaction.

The last resort in defense of the belief in "creative thinking" is usually the work of the artist, poet, and musician. The painter may give a new interpretation

on canvas, the poet may even invent a fantastic character or situation, and the great composer may create a new symphony. Each is as definitely dependent upon experience for his productions as is the inventor. He may hit upon a new technique, a new form of expression, and he may even present a "new truth," but each is necessarily the result of previous reactions. What constitutes originality is the new combination based upon the discovery of common hidden elements in experience closely analogous to the Chinese characters in the experiments on generalizing and abstracting.

**Reasoning and imagination.** Pillsbury has made the distinction between reasoning and imagination that the former is the old experience in a new way and true, while the latter is the old in a new way and not true. By "true" he means that the conclusion fits a real situation with which the subject is concerned. In imagination the conclusion is recognized as not meeting a real emergency. Thus, we might say that the process of thinking employed by Mark Twain when he invented the airship in which Tom Sawyer and his friends went abroad, was that of imagination, while the invention by the Wright brothers was reasoning. One recognized that his invention had no basis in reality, while the others had sufficient faith in it to construct the ship and risk their necks in it.

There is a second difference closely related to this. In imagination, defects in organization can be avoided. When Tom Sawyer wished his ship to go higher, he pressed a button. What the button did was not important. The speed was regulated by getting into the proper air strata. Their actual existence was again nothing that needed investigation. The inventor, on the other hand, must check every new principle. He may make an error,

but, so far as he knows, the invention will work. It is true in the sense that it conforms to his knowledge of the situation.

The main difference, then, between reasoning and imagination is the objective, or end to be served, in each case. Reasoning occurs when a definite situation presented is one which is unfamiliar to the subject—that is, one to which he has not previously reacted. A satisfactory solution is necessary. Imagination differs only in that the objective is less definite and satisfaction is obtained without the real obstacles of the situation being met. This, of course, is a mere matter of defining the two terms.

**"Fantasy thinking."** The term *imagination* is often used to refer to that implicit behavior which concerns no real present problem but which may at some future time be of service to the individual. He may imagine what he would do if his income were greatly increased, or if he found himself in a certain dangerous situation. This behavior may result in a partial organization to meet such emergencies. On the other hand, such behavior frequently becomes what is known as "fantasy thinking." The activity is sufficient unto itself, and the individual withdraws more and more from the world of reality into the world of fantasy, or daydreaming. He fails to make an adequate adjustment to his environment and gains satisfaction in dreaming imaginary situations.

A frequent situation in which this type of thinking is indulged is that of the student with poor study habits and unsatisfactory adjustment to the social conditions of college life. Application to the study at hand is difficult, partly because the student possesses inadequate knowledge, or poor vocabulary or reading habits. Consequently, he indulges in those activities which are easy

for him. He sharpens his pencil, arranges the books on his table, and so forth. His other conflict, the social maladjustment, also enters in. He imagines himself a football star, or the idol of "co-eds." This imagination gets to be a habit, so that every study hour becomes a fantasy hour.

**Individual differences in reasoning.** Some people are known for their reasoning ability, while others are encyclopedic, that is, they are good memorizers. One of the outstanding features of the present-day educational program is its aim to "teach students to think." This is often confused with two fallacies: First, that knowledge of facts is inimical to good reasoning; and second, that opinions are an indication of reasoning. One must have facts in order to formulate an adequate opinion or correct solution. Also, the acquisition of data, or memorizing, is not a process of "stuffing the mind," as one educator puts it, but is rather the accumulation of tools in the form of reaction patterns with which to reason. The real difficulty is that both memorizing and thinking are habits of reacting. One may form the habit of collecting data to the neglect of using the data when they are obtained.

The experiments in generalizing and abstracting are suggestive of the problems that confront the teacher in his efforts to set up those situations which will be most effective in developing the proper habits of thinking. The individual must first learn to abstract the elements. In the second place, he must be able to apply these abstractions to new situations. The habit of discriminating, then, is an important factor in the student's reasoning equipment. Closely allied to this is freedom from prejudice and from previous habits of reacting.

Perhaps the greatest obstacle to creative thinking, or reasoning, is our natural laziness or unwillingness to try

something new. Recently a professor complained that he found many of his students using a clumsy method they had learned in the eighth grade in preference to an easier method more recently explained. Some individuals have developed a habit of analyzing situations and making new applications, but most of us generally trudge the old, beaten path.

**The brain and thinking.** Too little of the nature and function of the nervous system is definitely known for us to arrive at an adequate explanation of thinking in terms of nervous conduction and brain function. We have seen that man surpasses the other vertebrates not so much in his methods of learning as in the degree of complexity of the problems he is able to solve. The apes have given some evidence of insight in relatively simple problems, and it is possible for them to perform a certain degree of abstracting, as, for example, when the ape substituted blanket for stick, although in this direction man far surpasses any of the other animals.

Correlated with this superiority in behavior is the enormous development of the cerebrum in man. No other animal has approached man in this development, particularly the development in the frontal lobes. Consequently, some have assumed the frontal lobes to be the seat of thinking. Recent studies refute this theory and place thinking as a function of the organism as a whole. In general, thinking is a process closely allied to learning, which involves the organization of receptor and effector mechanisms. The enormous increase in the number of possible neurone connections with the overgrowth of the cerebrum, together with the failure to discover definite localized areas of learning and thinking, makes it seem probable that the whole cerebrum is involved as the important organizing center.

## Questions for Review

1. Would a deaf and dumb person be at a disadvantage in an attempt to solve the bent-nail puzzle?

2. What is the evidence that indicates that thinking is largely implicit behavior?

3. What is the relationship between the processes of abstracting and generalizing? Cite some examples of both in your own experience.

4. In what way do the experiments on abstraction and generalization differ from the multiple choice experiment?

5. Make a brief list of some of the more important concepts that you have developed in your own experience (honesty, etc.). Show that these concepts are patterns of abstractions.

6. What is the chief contribution of Hull's work on the evolution of concepts?

7. In what ways do concepts resemble perceptions? Are the two identical?

8. What are the steps in the reasoning process?

9. List some of the factors which may be responsible for delay of the solution in a problem situation.

10. In what way is creative thinking related to past experience?

11. Why are we not justified in saying that modern man is more inventive or creative than his primitive ancestors?

12. Comment on the statement, "Education should consist in training to think, not in the acquisition of facts."

13. What part of the nervous system seems to play the most important rôle in thinking?

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## SECTION X. LEVELS OF ATTAINMENT



References to Student's Guide:

Exercise 94. An Analysis of Contributing Factors in Human Behavior
Exercise 97. Prediction of Academic Success from Intelligence Test Scores
Exercise 99. The Strong Interest Scale
Exercise 100. An Interest Autobiography
Exercise 101. Construction of an Aptitude Test
Exercise 102. An Analysis of a Course
Exercise 103. The Seashore (or Kwalwasser-Dykema) Musical Aptitude Test

## CHAPTER XXVII

# The Measurement of Intelligence

From infancy to adulthood, individuals go through the processes of maturing and of learning. It is through these two processes that the individual reaches a stage of development which we call *maturity*. We recognize that some individuals reach a higher level of attainment than others. We also see clearly that some children learn more readily than others. Then we raise the question as to the cause of these differences. Is it because some individuals are given better opportunities for learning that they are more highly motivated, or is there a hereditary difference which is responsible for the differences noted? These differences have led to the concept of *intelligence*. We say that one child is bright, or *intelligent*, and that another is dull, or *feeble-minded*.

Inasmuch as we cannot separate the influences of maturation and learning, or the factors of heredity and environmental opportunity for development, we should consider the differences merely on the basis of the levels of attainment. It is desirable, however, to make the attempt to discover whether there are individual differences which are due to the natural capacity or hereditary factors in the individual. In order to do this, it is necessary to select factors in the environment which are common to all individuals and to try to determine how the various individuals in this social group have benefited by contact with these influences. If, for example, money in

the form of pennies, nickels, and dimes is freely passed among individuals, we would expect that all of the individuals, if they are of the same age and have had the same opportunities for learning them, ought to be able to recognize these coins. On the other hand, we should not expect all individuals to have the same opportunity for learning how to read or how to extract the square root.

If we are to build tests which will in any way discover the relative degree of intelligence or natural ability, we must select items which bear upon the common factors in the environment of the whole group. Actually, we are testing accomplishment or attainment, just as the test of a school subject does. There is, however, another factor to be considered. The situation presented in the test may be something new. For example, a puzzle may be of a type which has not been experienced by any of the individuals. It may be some situation which requires what we call "reason" in which all of the facts necessary for the solution are presented. In this case we attempt to discover what, on the basis of common knowledge, the individual can do. We know, for example, that a child five years old should be able to do some things which a child three years old cannot do—not merely because he has two years more of experience, but because he has two years more of growth. Some of our tests, therefore, are designed for the purpose of determining as nearly as possible what the individual can accomplish with the physical development which he possesses.

**Intelligence and specialization.** Very often an individual is considered very bright because he possesses a high degree of specialization in one field. For example, he may be an expert mechanic, or he may have an excellent memory for dates or names. Such cases when examined show that the individual has spent an unusual

amount of time in learning this particular skill. Moreover, the individual may prove very inadequate in other ways. Again, we may overrate the general intelligence of a student because he always makes high grades in his courses, whereas the real reason for his success is that he studies four times as long as another man who may be equally capable but indifferent to the subject matter at hand. It is for this reason that the attempt to measure intelligence is important. It is very desirable that the individual spend as much time and energy as possible in the attainment of high scholarship or special skills, but it is also important that we know how much the various individuals in the group can attain provided they have devoted the same time and energy to learning.

**Arbitrary measures of attainment.** Attainment may be described in various ways. If we desire to determine the success of college graduates, we usually attempt to rate their positions. We determine the salaries of college graduates and of non-college graduates, or we investigate their records as shown by their social recognition, such as the number rated in *Who's Who in America,* or the number that have been elected to the legislature or to other public offices. These standards are purely social ones which may not indicate the true success of the individual in any important way.

## The Importance of Tests

**In the schools.** We frequently make gross errors in judging children in school when we rely entirely upon their performance in the schoolroom. One child is said to be bright, but he is doing well only because he is repeating the grade. Another is said to be dull when, as a matter of fact, he has been too much interested in some-

thing other than his school work. By the use of one or more of the standardized tests, it may be discovered that he can be encouraged to do more work and pass more rapidly from grade to grade. Many times the "bad boy" in school has not enough to do. Special tests may also uncover his strong and weak points, and his treatment can then be adjusted accordingly.

Most schools now recognize that not all children can progress at the same rate. Special classes are provided for the slow pupils. By the use of tests such as have been described this sectioning, not only for the slow pupils but also for the exceptionally alert pupils, can be quickly obtained. The great danger is that we are likely to stop at this point. It should be remembered that these tests rarely give a correlation above $r = .60$. There are other factors, such as home conditions, language difficulties, health, and special interests, that must also be investigated.

**The delinquent.** What is true of the school child is true also of the delinquent and the adult criminal. Not all delinquents are below normal in their performance index. The test, however, is a good point of departure in investigating him in order to provide the proper corrective. Contrary to the two extremes of popular belief, a relatively small per cent of delinquents display a performance index above normal, and all are not feeble-minded.

Social conditions seem to be as important as native equipment or the level of attainment. Doubtless, the inferior generally find the social restraint more difficult than their brighter associates. The principal value of the tests here is to help select the groups for special treatment. Again, the problem is threefold: social, psychological, and medical.

**The college student.** Studies indicate that college students in the lowest ranks according to test scores either fail or drop out of college before graduation, while those who win Phi Beta Kappa are almost wholly from the upper 50 per cent. These tests are more specifically tests of school attainment. They are designed primarily to predict college success.

Furthermore, it should be understood that the two extremes are not so far removed as is sometimes supposed, if we are considering general attainment levels other than academic success. The college students make up an already selected group. They are not necessarily the most superior individually, but at least the decidedly inferior have already been eliminated.

One of the principal uses of the test score is as a guide to the student and his instructors. If the student rates low, his success will depend upon greater energy and improved study habits. If he rates high, his program can be arranged to give him greater opportunities for broader or more advanced study. More time can be spent on outside activities, or a greater amount of work can be undertaken. His academic progress is greater than that of the student who rates low, if he takes advantage of his opportunities.

**Selection of employees.** Tests for the selection or classification of workers are of two types. In the one case, the tasks to be performed are analyzed and tests that will measure the specific functions required, such as visual or auditory acuity, speed of movement, and resistance to monotony, are devised. In the other, the tests are trade tests, or an examination of the skill or knowledge already attained. The former is of more interest to the psychologist. Tests have been devised for the selection of men to be trained as machine operators,

retail salesmen, typists, comptometer operators, and workers in a great many other positions.

**Vocational guidance.** There is a growing demand for tests that will furnish accurate information to serve as a basis for advising young men and young women as to what line of activity they are most fitted for and as to whether or not they should prepare for medicine, law, business, engineering, or some other occupation. In the simpler occupations, this is already somewhat feasible. The man who makes a poor record in the tapping test and in verbal learning will have a poor chance as a telegraph operator or typist, but may possess the qualifications necessary for a plumber or a carpenter.

It is less easy to select the major traits that distinguish the professions. The practice of medicine is extremely varied, as is that of law. The physician must possess a good memory, quick adjustment to new situations, and sociability or some other social trait. But the lawyer requires the same traits, and so does the engineer. Tests at present can do little more than discover how much the present attainments conform with specific requirements in one profession or another.

For the most part, vocational selection must rest upon the individual's interests. He has come into contact with many lines of activity and has developed along the lines of greatest interest. The only drawback is the limitations of his experience. A young man in a small country high school may be interested in chemistry and may decide to become a pharmacist because that is the only occupation in which he sees the use of any chemistry. Usually, however, he either makes new contacts and goes on to more advanced chemistry, or he reaches his own general level of attainment.

These deficiencies do not mean that there is no outlook

for scientific vocational guidance. The field is relatively unexplored, but it is so large that the possibilities are unlimited. The solution will rest not in the development of tests alone, but in the development of tests combined with the investigation of the whole social structure.

**Standardizing tests of performance.** We always make our judgments on a relative standard. Thus, we say that one man is tall because he is taller than others in the group. We say that a boy is bright because he is brighter than the other boys in his class: in another class, he might not be considered so bright. Standardized tests are based on this principle. When a test is given to a large group of children and some do better than others, a standard is set on the basis of these differences in performance.

Let us assume that we wish to determine the level of performance that has been reached at the age of 5 years. We may give a variety of test situations to a large number of children of this age. If a large percentage of them are able to answer the questions or to perform the tasks, we might say that this is the type of performance to be expected of 5-year-olds.

However, if the same group of situations were presented to 4-year-old children, we might find that they could do equally as well. In this case, our measure would somehow be inadequate. For this reason, the test situations must be presented to a large number of children of different ages, and by means of some standard it must be determined at what age level the tests are applicable. Usually, it is considered that if a group of tests can be passed by from 60 per cent to 75 per cent of one age group, by a definitely lower per cent of the next group below, and by a definitely larger per cent of the next group above, the tests are adequate measures for the par-

ticular age under consideration. By trying out groups of tests at the different age levels, it is possible to establish "norms" for each age and thereby to construct a series of tests which may be applied to any individual within these age limits and which may determine his level of attainment with reference to this group.

**Levels of attainment of infants.** In the studies of infant behavior, a variety of situations are presented for the purpose of determining how the infant learns to manipulate, how he learns to walk, the order of speech development, and his reactions to social situations. These situations also present an opportunity for determining the age at which the infant attains skills of various kinds. These performances have been grouped according to age and thus furnish a series of tests at each age level. The results are summarized under the headings: motor characteristics, language, adaptive behavior, and personal-social behavior. Samples of these norms are given in Table XIV.[1]

It would be possible, if one were observing an infant, say, 6 months old, to determine fairly accurately by reference to these norms whether he had reached approximately the stage of development and the level of performance that is to be expected at this age. When a robust infant 6 months old was presented to a group of observers, they variously estimated his age as being from 4 months to 2 years. Had they had before them the norms of performance of infants, they could have observed the behavior of this particular infant and more nearly have approximated its level of development.

**Norms for school age.** The most thorough work in standardizing norms of attainment has been done for the

[1] Gesell, Arnold, *The Mental Growth of the Pre-school Child,* New York, the Macmillan Company, 1926.

ages from 5 to 14 years. This is largely due to the fact that children between these ages are more available in the public schools. The first set of tests was devised by Binet in about 1905, for use in a survey of the attainment levels of children in the schools of Paris. In 1911, his tests were translated and revised by Goddard to meet American conditions. The Goddard revision gave the great impetus to the development of tests of this type

TABLE XIV

GESELL'S NORMS FOR INFANTS

| | *4 Months* | *6 Months* | *12 Months* |
|---|---|---|---|
| *Motor Characteristics* | Prefers to lie on back. Tries to raise self, lifting head and shoulders. Can roll from back to side (side to back). Holds head erect when carried. Lifts head when prone. Pushes with feet against floor when held. | Prefers to sit up, with support. Can roll from back to stomach (stomach to back). Uses hands to reach, grasp, crumple, bang, and splash. Opposes thumb in grasping cube. | Stands with support. Creeps or hitches along. Walks with help. Shows a preference for one hand in reaching. Scribbles imitatively with a crayon. |
| *Language* | Coos. Smiles. Laughs aloud. Makes several vocalizations. | Coos to music. Articulates many syllables in spontaneous vocalization. Frequently laughs at sights and sounds. Is responsive to animated facial expressions. | Comprehends simple verbal commissions. Says two words besides *mama* and *dada*. Can wave *bye bye* and can often say it. |

Gesell's Norms for Infants (cont.)

| | *4 Months* | *6 Months* | *12 Months* |
|---|---|---|---|
| *Adaptive Behavior* | Notices large objects.<br>May notice spoon on table.<br>Hands react to table. | Notices small objects, like cube, on table.<br>Picks up objects from table.<br>Bangs spoon.<br>Clasps dangling ring.<br>Shows varied selective attention to environment. | Places a cube in a cup on command.<br>Recovers a cube concealed by a cup.<br>Retains a cube in either hand and takes a third.<br>Puts a small rod in a half-inch hole. |
| *Personal-Social Behavior* | Shows selective interest in animated face.<br>Makes anticipatory postural adjustment on being lifted.<br>Not much affected by strange persons, new scenes, or solitude.<br>Turns head to voice.<br>Plays with hands. | Plays actively with rattle.<br>Expresses recognition of familiar persons.<br>May show consciousness of strangers.<br>Enjoys presence and playfulness of persons. | Plays with or reaches for his mirror image.<br>Coöperates while he is being dressed.<br>Holds cup to drink out of it and may use spoon.<br>Plays with blocks but not very constructively.<br>Inhibits simple acts on command.<br>Imitates simple acts like scribble and spoon rattle. |

and to their use in this country. Binet sought to use material which was met by the individual children in everyday experience rather than the specific material taught in the classroom. Some of the tests for the various ages are given in Table XV. These tests, consisting

TABLE XV
BINET TEST ITEMS

| *Age 5* | *Age 6* | *Age 7* |
|---|---|---|
| 1. Compares two weights.<br>2. Copies a square.<br>3. Repeats a sentence of ten syllables.<br>4. Counts four pennies.<br>5. Unites the halves of a divided rectangle. | 1. Distinguishes between morning and afternoon.<br>2. Defines familiar words in terms of use.<br>3. Copies a diamond.<br>4. Counts thirteen pennies.<br>5. Distinguishes pictures of ugly and pretty foxes. | 1. Shows right hand and left ear.<br>2. Describes a picture.<br>3. Executes three commissions given simultaneously.<br>4. Counts the value of six sous, three of which are double.<br>5. Names four cardinal colors. |
| *Age 10* | *Age 12* | |
| 1. Arranges five blocks in order of weight.<br>2. Copies drawings from memory.<br>3. Criticizes absurd statements.<br>4. Answers difficult "comprehension questions."<br>5. Uses three given words in not more than two sentences. | 1. Resists suggestion.<br>2. Composes one sentence containing three given words.<br>3. Names sixty words in three minutes.<br>4. Defines certain abstract words.<br>5. Discovers the sense of a disarranged sentence. | |

of 54 items, were arranged in groups for individuals from the ages of 3 to 14, the latter of which was considered the adult age.

**Mental age.** On the basis of these tests, Binet also developed the concept of "mental age." A child who was 5 years old and who could pass the items at the 5-

year level was considered to have the "mental age" of 5 years. If, however, he could also pass the items for the 6-year level, he possessed the 6-year mental age; consequently, one could distinguish between chronological age and mental age.

One of the unfortunate consequences of this mental-age concept has been that it is too frequently assumed that the test is a complete measure of the performance level of the individual; that, once having tested a person by this method, we have a complete picture of the individual as to his performance in any other type of test situation.

If, however, we limit the term "mental age" to the test under consideration, it is a convenient way of stating the performance of an individual with reference to a group. So far as this particular test is concerned, he has a performance level equal to that of the average child of 6 years, for example. His mental age is, therefore, 6 years. Frequently, when it is desired to make clear that the estimate is conservative, the performance level is designated "Binet mental age" to indicate that nothing more is implied than that the individual under consideration passes a particular level of the Binet test.

**Limitations of tests.** Closely related to the mental-age concept is another factor which is often overlooked. An individual is always limited in his performance by the test which is given. If a college student is given a six-year-old test, he may perform the test correctly, although that is also done by the six-year-old. A set of tests devised for children was given to a large group of soldiers in the Army during the War with the result that the average "mental age" was found to be 13 years. This does not mean that the average degree of intelligence or level of attainment of the American soldiers

was actually that of a thirteen-year-old, because the test limited his performance. We might assume that there were a great many other accomplishments which the soldiers did possess, but which would not have been possessed by thirteen-year-old children, which could have been discovered by other tests. It is therefore necessary to remember at all times when dealing with test scores that we cannot generalize on the results beyond the immediate factors involved in the tests.

**Stanford revision of Binet tests.** In 1916, Terman published the revision of Binet tests which he and his associates at Stanford University had made. The chief differences between this revision and the original Binet test and the Goddard revision of it are:

1. A larger number of items than is included in the Binet tests was submitted for standardization.
2. A larger number of children than had heretofore been used in this country was used to establish the norms.
3. These children were more carefully selected.

In order that the children might be as representative as possible of each age group, only children supposedly normal and within 2 months of a birthday were employed. Approximately 2,300 subjects were used, including 1,700 normal school children. If a test did not prove satisfactory, it was eliminated from the final series. The criterion for a satisfactory test was, again, that it should be passed by a sufficient majority of the children of a particular age level, that it should not be passed by many of the next lower age level, and that it should be passed by a sufficiently increased number at the next higher age level.

When this list of items was completed, there were at least 6 items for each age from 3 to 10 years, 8 items at

12 years, and 6 items for each of the levels at 14 years—"average adult" and "superior adult." In most cases, there were also provided alternative tests which might be substituted for any one of the test items. In this scheme, a subject is given 2 months' credit for each satisfactorily passed item in the earlier groups up to and including the 10-year level. There is no test for the 11-year level, but there are 8 tests at 12 years. Therefore, 3 months' credit is given for each of these tests. There is no test at the 13-year level, and at the 14-year level there are 6 tests each counting 4 months.

For example, a child might pass all of the 9-year tests, 2 of the 10-year tests, and 1 of the 12-year tests. In addition to the 9-year-old credit, he would receive a credit of 2 additional months for each test of the 10-year level passed, and 3 months for the one of the 12-year level, thus making his mental age on the whole test 9 years, 7 months. Another important change is that of the extension of the test beyond the age of 14 years, which was considered the adult level by Binet, thus extending the age limit covered by tests to approximately 20 years. During this revision, it was found that some of the Binet tests were too difficult at the level at which they had been placed while others were too easy.

It was the original plan that tests at a specified level would be given. If the child passed these, the next higher level should be tried. However, it is becoming common practice to give a wide range of tests regardless of the age level, and to determine the child's level of attainment by allowing so many months for each test passed. Consequently, the particular level in the scale at which a test is placed is not so important.

**Technique in testing.** Some very important factors in administering tests of this character are:

1. The establishing of the proper degree of initiative, or motive, on the part of the individual to be examined.

2. The faithful adherence to the literal form in which the test is cast.

3. Judgment of the performance that is satisfactory according to standards already established for the tests.

The first is dependent very largely upon the personal factor of the examiner, but requires careful consideration with respect to the setting in which the test is given. First of all, the examiner and the examinee should be alone, and, above all, no other person directly interested in the child should be present. The child must be encouraged and, at the same time, must not be excited with reference to the testing program.

In the second place, adherence to the exact form of the test is of very great importance. For example, in the definitions of objects, such as chair, horse, fork, doll, pencil, and table (age 5, test 4), the formula is: "You have seen a chair. You know what a chair is. Tell me what is a chair?" This formula must not be altered. Again, at age 7, test 4—tying a bowknot—an ordinary double bowknot tied in a shoe string about a stick is placed before the child. Then this formula is given: "You know what kind of knot this is, don't you? It is a bowknot. I want you to take this other piece of string and tie the same kind of knot around my finger." In giving differences from memory (age 7, test 5), say: "What is the difference between a fly and a butterfly?" If the child does not seem to understand, say: "You know flies, do you not? You have seen flies? And you know butterflies. Now, tell me the difference between a fly and a butterfly."

This often sounds nonsensical, but it is easy to vary the form to such an extent that it becomes a matter of coaching the child to say, or do, what you want, in one case, and of rendering the test too difficult in another. Either result renders the test unfair and invalid.

The next matter that requires careful consideration is the satisfactory scoring of the answers. In most cases, the answers will conform very nearly to standard answers collected by Terman. The answers that are considered satisfactory in the first test mentioned (age 5, test 4) are in terms of use. "A chair is something to sit on." "A horse is something to drive or to ride." At a later age, answers will be superior to use; that is, definitions by description, or by telling the class to which the thing being defined belongs, will be given.

These answers are generally based upon the fact that nearly all normal children have met the same things in their environment and react to them in very much the same way. Many times, however, exceptions occur which need investigation in order that they may be evaluated properly. In one case, a boy, when asked "What is the thing to do if it is raining when you start to school," replied, "Go anyway." The correct answer was, "Take an umbrella" or "Wear a raincoat." In this particular instance, the boy lived in an orphanage. No raincoats or umbrellas were available, and the children were instructed that, when it rained, they should go to school anyway. The boy's answer was satisfactory according to the environment in which he had lived. If the examiner had not known the circumstances, the boy would have been marked as not passing that particular test.

**Intelligence quotient.** As a convenient method of stating the result of the test, Terman inaugurated the

use of the intelligence quotient (IQ). This is determined by dividing the mental age by the chronological age and multiplying the result by 100. Thus, if a child scores 6 years on the test and is 6 years old, his intelligence quotient is represented as 100. If he is 5 years old and passes the 6-year level, his IQ equals 120. This method is open to the same objections as the use of mental age in that it really represents only the result of this particular test and should not be considered as a satisfactory measure of the intelligence, or general mental ability, of the individual. It is, rather, a measure of attainment in this particular test.

This statement should not be taken as discouraging entirely the application of such tests for purposes of determining the general attainment level. A careful check-up of the success of a large group of children in the schools indicates that there is a rather close correlation between their IQ's and their ratings in school work by the teachers. That the tests are valid as differentiating bright and dull children is indicated by the distribution of the IQ's of 905 unselected children between the ages of 5 and 14 years (Figure 79). It will be seen that this distribution very closely approximates the normal dis-

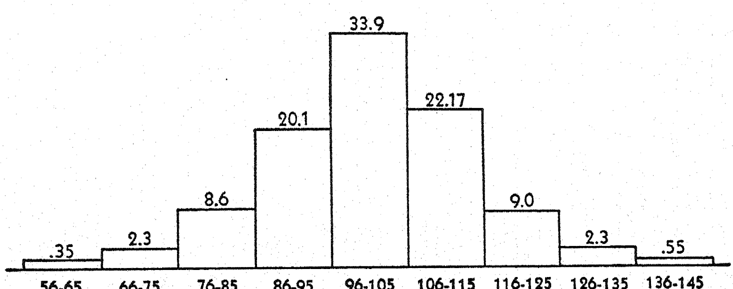


**Figure 79.—Distribution of IQ's of 905 Unselected Children 5–14 Years of Age.** (*Terman.*)

tribution curve. It demonstrates (1) that the frequency of the various performance levels decreases gradually on either side of the median, and (2) that the extreme deviations below the median are equalled by extreme deviations above. It is not necessary that curves of attainment approximate the normal distribution. Any other curve could be used, but this is usually more convenient.

**The concept of general intelligence.** In the description of methods of testing levels of attainment, the question naturally arises as to what it is, after all, that we are trying to test. We have met with the terms "mental age" and "intelligence quotient," both of which suggest that back of attainment there is something intrinsically fundamental in the equipment of the individual. Most of the earlier workers with tests have started with the concept of intelligence and have attempted to develop tests which would be a measure of it. With the further development of tests, the question as to whether the tests were really tests of intelligence or of something else grew more pronounced.

Intelligence was a concept in the study of animal behavior before the so-called "intelligence" tests were developed. The problem there was intelligence versus instinct: Was the lower animal really intelligent, or was his behavior entirely determined and automatic? If it could be shown that the animal could learn new patterns, or that he could make new adjustments, then he was intelligent. It was assumed, therefore, that intelligence meant a higher level of ability, presumably mental, which was certainly possessed by man and in the case of the lower animal was problematical.

A definition of intelligence, however, was more difficult. Usually it is stated in somewhat the following terms: "General intelligence is the ability of the organ-

ism to adjust itself adequately to new situations," or, "Intelligence is the general capacity of an individual consciously to adjust his thinking to new requirements." Ability and capacity refer to the potentiality of the individual, or the neuromuscular equipment which is inherited, and not to the physical and social elements of the environment.

If we accept this definition of intelligence and the assumption that it is based on inherited equipment, the next question that we must answer is: Do the tests already described measure intelligence, and will they strictly depend on this innate equipment or on variations in the environment? The principal characteristic involved in the definition of intelligence is adaptability to new conditions or the establishment of new adjustments to changing situations. A review of the items in the Binet test will show that some of these items might be considered a type which calls for a readjustment, for example, "What's the thing to do if you find that your house is on fire?" This is distinctly a problem which is set up at the moment, though the real problem involved is the thing to do when the house is on fire. In the test situation, however, it is a call for a present adjustment, particularly in verbal terms. Most of the tests are of this character. Tying a bowknot, on the other hand, calls for observation and performance which will give the same result as that observed. The former case is based upon the assumption that the individual has lived in a normal environment and has learned what to do. He has observed phenomena and, as a result, can talk about them.

In this sense, the tests are really "alertness" tests. In many cases, the newer tests have been called "alertness" tests rather than "intelligence" tests. This sug-

gests that the individuals with high scores have been more active and quicker in making observations and in reacting to new situations, and that hence their attainment is superior. On the other hand, it may be questioned whether the tests measure even a fair sample of native ability or whether they are dependent entirely, or very largely, upon the social development of the individual.

**Heredity and intelligence.** Perhaps the best proof of what these tests measure is the result obtained from their application to individuals whose heredity is known. For example, if it were possible to estimate the general intelligence level of both the parents and the foster parents of a number of children who had been reared by foster parents, we would have a group in which the hereditary and environmental factors were totally different.

Such tests have been given to children who have been adopted in early infancy by parents whose average intelligence is estimated to be an IQ of 115. Most of these children were the offspring of unmarried girls who could not take care of them. Presumably the average IQ of the mothers was below normal. As nothing could be known of the fathers, a conservative estimate of the average IQ of these parents was placed at not greater than normal (IQ 100). The average IQ of the children has been found to be from 104 to 107.

This would indicate that if the estimate of the parents' intelligence is correct, the environment of the better home of the foster parents exerts some influence in raising the IQ, but that heredity has prevented the raising of the IQ to the equal of that of the foster parents.

Terman has investigated a number of cases in which several children in the same family were tested. If the

social factor is the only factor, all of the children of one family ought to have the same intelligence quotient, as they have been reared under very nearly identical conditions. He finds, however, that in the family of low social status, with parents of intelligence estimated to be low, most of the children will test below normal, but one or more may have a very high IQ. This result is what might be expected on the basis of what is known regarding heredity.

We may conclude, therefore, that such tests are tests of attainment, or what the individual has learned. As the tests are based upon those items to which all individuals in the group have been equally exposed, they should be measures of native equipment. We cannot measure native equipment as such. We measure behavior, and behavior is learned. Hence, if one individual at 6 years of age is superior to another of the same age, we can say that, to the extent that each has had equal opportunity of achievement, the one who tests higher is the superior.

However, as the *level* of attainment is what we are really testing, native equipment is measured only indirectly. It would be more consistent with our procedure to substitute "attainment index" (AI), or "performance index" (PI), for the commonly used intelligence quotient. Thus, if a child 6 years old satisfactorily passes the tests normally passed at that age, he would be given an AI of 100.

## Questions for Review

1. What is the theory which lies behind attempts to measure intelligence by achievement tests?

2. To what uses have the results of tests been put? What are some of the assumptions which underlie the interpretation of these test results?

3. Outline the procedure involved in standardizing a test.

4. Describe some of the tests used to determine the level of attainment of infants.

5. To what type of performance does the term "mental age" refer? What limitations must be remembered in its interpretation?

6. What are some of the important factors to be remembered in the administration of the Binet tests?

7. How does Figure 79 indicate that the IQ may be used to differentiate the bright from the dull children?

8. What is the relationship among tests of "alertness," tests of "attainment," and tests of "intelligence"?

9. To what extent may intelligence be inherited? What is the evidence that points to a heredity factor in intelligence?

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Schwesinger, Gladys C., *Heredity and Environment,* New York, the Macmillan Company, 1933, pp. 5–38.

## CHAPTER XXVIII

# The Attainment of Groups

**Group tests.** In the testing of a large number of persons, the individual test requires so much time that it is desirable to have a form which can be applied simultaneously to a large group. This has led to the so-called "group" test, which is generally a "paper and pencil" test. The items are listed, and specific directions are either printed with the tests or given by the examiner orally or in pantomime. These may be roughly classified as:

1. Tests for subjects with a good degree of literacy, the directions and test items being printed.

2. Tests in which the directions are given orally and the responses can be made by subjects who can neither read nor write English, such as foreigners and young children.

3. Tests of the strictly non-verbal type, in which the directions are given by pantomime illustration to those who do not understand English—such as some of the foreign-born—and the deaf.

While the individual tests of the Binet type are based very largely on language ability, most group tests involve literacy attainment, a fact which still further complicates the situation. Even among those who can read, the speed of reading will vary considerably. Special education, or schooling, therefore, is an added factor in the group form of examination.

**Army Alpha.** Group tests were devised during the War to test the soldiers for the purposes of classification and of the selection of officers. Nearly two million men were tested in this way. These tests, generally known as the "Army Alpha," were divided into 8 parts or tests. The first involved the following of directions, such as, "Write the number 'one' so that it will be in the square and in the triangle, but not in the circle; and the number 'two' so that it will be in the square and in the circle, but not in the triangle." The second test involved the solution of arithmetical problems in which the important factor was not so much the arithmetical computation as it was reasoning ability. The first problems are easy, and the rest grow progressively more difficult. The third test is a test of "common sense," and is of the multiple-choice type. For example,

1. If plants are dying for lack of rain, you should
   ( ) water them
   ( ) ask a florist's advice
   ( ) put fertilizer around them
2. A house is better than a tent because
   ( ) it costs more
   ( ) it is more comfortable
   ( ) it is made of wood
3. Why does it pay to get a good education? Because
   ( ) it makes a man more useful and happy
   ( ) it makes work for teachers
   ( ) it makes demand for buildings for schools and colleges

Test 4 is a "same and opposite" test. The subject is to underline "same" or "opposite," corresponding to each pair of terms given. For example:

| | | |
|---|---|---|
| 1. cold—hot | same | opposite |
| 2. long—short | same | opposite |
| 3. bare—naked | same | opposite |
| 4. joy—happiness | same | opposite |
| 5. find—lose | same | opposite |

Test 5 is made up of sentences with words disarranged. The subject is to rearrange the words to make a sentence, and to decide whether the statement is true or false. For example:

| | | |
|---|---|---|
| 1. cows milk give. | true | false |
| 2. write are with to pencils. | true | false |
| 3. are and apples long thin. | true | false |
| 4. east the in rises sun the. | true | false |
| 5. months warmest are summer the. | true | false |

Test 8 was a general information test in which 4 answers were given to each statement, and the subject was to underline the correct answer, as:

1. Maize is a kind of corn hay oats rice.
2. Nabisco is a patent medicine disinfectant food product tooth paste.
3. Velvet Joe appears in advertisements of tooth powder dry goods tobacco soap.
4. Cypress is a kind of machine food tree fabric.
5. Bombay is a city in China Egypt India Japan.

A time limit was set for each test, and the number of items was sufficient to make it possible for only a very few to answer all of them in the time allowed. The tests, therefore, involved general information, reasoning ability, ability to follow directions, and speed of perform-

ance. The results are illustrated in the distribution curves in Figure 80. It will be seen that most officers

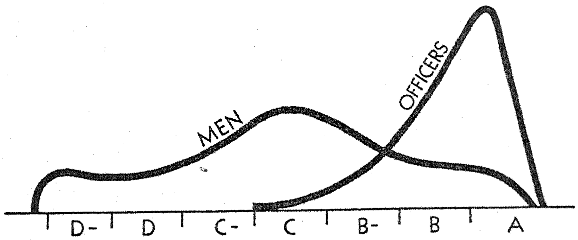


**Figure 80.—Distribution of Ratings of 82,936 Literate Enlisted Men and 8,819 Commissioned Officers.**

score higher than most men in the ranks, though some officers score below the median for a common soldier, and a few soldiers score as high as the highest score made by any officer.

**Importance of variety of items.** As one reads for the first time the items included in such tests as the Alpha, he may be inclined to object that the items are unfair and in many instances absurd. Why should one be judged nonintelligent because he does not know that spruce is a tree and Nabisco is not a fruit? It does not seem important that he should know anything about Velvet Joe or John Wesley or the White Sox. It is true that a test would be unfair or inadequate if it contained only a few items and all were of this sort. But group tests are made up of a very large number of items from a variety of fields all of which are fairly well represented in the environment of the majority of individuals. Therefore we might say that the individual who can mark the greatest number of items correctly is more alert to his surroundings or more enthusiastic in learning everything with which he comes in contact. The ap-

parent absurdity disappears when one considers the test as a whole.

**Speed an important factor.** It is often objected that the individual could answer the items provided that he were given more time. It is pointed out that some individuals read and think more slowly than others. However, speed is one of the important factors in everyday life. The individual who can think or act quickly is superior in that respect to the individual who is slow. It is also found that the slow individual, if given more time, does not perform so much better relatively as might be expected. When two forms of the same test were given to the same group of individuals, more time being allowed in one case, it was found that the same general order of rank was maintained: those who had done the best with the limited time allowed also ranked at the top when more time was allowed.

**Occupation and test scores.** One of the questions that arises in connection with such tests is whether the performance of one occupational group, nationality, or race will be superior to that of another. The distribution of scores in the Army (Figure 80) clearly indicates that the majority of the commissioned officers scored higher than the average of the soldiers. Table XVI gives the average scores of different occupational groups. The scores are in terms of the number of points made out of a possible 212. The first column gives the first quartile score, or the score which 25 per cent fail to pass (25 centile). The second column gives the average, or 50 centile. The third column gives the third quartile, or the score which three-fourths of the group fail to pass (75 centile). The Army also employed the letter grades *A, B, C, D,* and *E* to classify the scores. Thus, the general average scores

were in grade *C*. *B* represented high average and *A*, superior.

The test performance of the engineer officers was superior to that of any other group. The general mechanic outranked the bricklayer, while the farmer and common laborer were at the bottom of the list. There are several possible interpretations of these results. It might be inferred that:

1. These scores indicate that those in a given occupation possess a certain level of attainment which is the result of native equipment.
2. Occupations differ in the native ability required, and through competition those of lower ability are crowded down into the occupations in which this demand is not so great.
3. The particular demands of this examination are met by one occupational group more completely than by another.

The farmer may possess as great general ability (native equipment) as the bricklayer, but this particular test does not measure his attainments so well. The sampling gives the advantage to the other groups.

**National and race differences.** It would also be interesting to know whether peoples of different countries and races possess different degrees of natural ability. The soldiers were classified according to their national origin, and the average scores of the various groups were classified. The results are shown in Table XVII. It will be observed that the men from northern Europe are generally superior to those from southern Europe. Here, again, it is problematical whether these differences are due to similarities and differences in language or to the social status of the different groups. In other words, if those coming to this country from Italy are of an inferior

class socially, their opportunity of development might be markedly inferior to that of those coming from the more favored groups.

TABLE XVI

ARMY ALPHA SCORES OF OCCUPATIONAL GROUPS

| *Occupational Group* | *First Quartile* | *Average* | *Third Quartile* | *Per Cent in Class A or B* |
|---|---|---|---|---|
| Engineer officer | 144 | 162 | 176 | 96 |
| Medical officer | 117 | 129 | 152 | 77 |
| Mechanical draftsman | 84 | 114 | 139 | 59 |
| Mechanical engineer | 73 | 110 | 137 | 47 |
| Bookkeeper | 77 | 101 | 127 | 46 |
| Telegrapher | 61 | 85 | 110 | 28 |
| General mechanic | 48 | 68 | 94 | 14 |
| Toolroom expert | 50 | 67 | 92 | 9 |
| Telephone lineman | 43 | 64 | 88 | 12 |
| Bricklayer | 37 | 58 | 88 | 11 |
| Barber | 34 | 55 | 78 | 7 |
| Teamster | 30 | 50 | 72 | 6 |
| Miner | 40 | 49 | 71 | 5 |
| Farmer | 30 | 48 | 73 | 7 |
| Laborer | 28 | 47 | 68 | 4 |

This has been one of the problems in the making of comparisons between races, particularly in the attempts to determine the average level of attainment and, therefore, the native ability of the American Indian and Negro. Numerous investigators have attacked this problem by selecting for comparison a group of Negroes and a group of whites each of which approximated the same social status. It is doubtful whether one can ever

select a group of Negroes who have the same social advantages in this country as a group of whites, even though the latter are rated on the same economic level. In general, the Negro has been found to rate about 20 per cent below the white on the tests given.

TABLE XVII

DISTRIBUTION OF ARMY ALPHA SCORES OF GROUPS OF DIFFERENT NATIONAL ORIGINS

| *National Origin* | *Per Cent A, B* | *Per Cent D, D—, E* |
|---|---|---|
| England | 19.7 | 8.7 |
| Scotland | 13.0 | 13.6 |
| White draft | 12.1 | 24.1 |
| Holland | 10.7 | 9.2 |
| Canada | 10.5 | 19.5 |
| Germany | 8.3 | 15.0 |
| Denmark | 5.4 | 13.4 |
| Sweden | 4.3 | 19.4 |
| Norway | 4.1 | 25.6 |
| Ireland | 4.1 | 39.4 |
| All foreign countries | 4.0 | 45.6 |
| Turkey | 3.4 | 42.0 |
| Austria | 3.4 | 37.5 |
| Russia | 2.7 | 60.4 |
| Greece | 2.1 | 43.6 |
| Italy | 0.8 | 63.4 |
| Belgium | 0.8 | 24.0 |
| Poland | 0.5 | 69.9 |

**A study of degree of race difference.** In a comparison of Indians, this difficulty was partially met by the classifi-

cation of the Indians according to the degree of Indian and white blood.[1] They were a relatively homogeneous group, all attending the Haskell Institute. The Otis test, used in this case, is somewhat similar to the Army Alpha and has been standardized for normal whites. The median score for the Indians was 83, as compared with the median score of 123 for the whites. The difference is more convincing, however, when the norms are compared according to the degree of Indian blood, as is shown in Figure 81. It will be seen that only 25.7 per cent of the quarter-bloods scored above the Otis norms at their age level, while 74.3 per cent scored below. There is a progressive shift of these scores as we pass to the half-bloods and three-quarter-bloods.

**Non-language performance tests.** In all of the tests thus far described, a larger factor in the performance is the ability to use the language involved. This factor offers a serious handicap to the foreign-born and to those who have lived in families in which English is not the prevalent language. It is also a serious handicap to the deaf. To meet this difficulty, numerous tests which require manual performance rather than verbal responses have been devised. Even the directions in many cases are given by signs without printed or spoken language.[2]

A group of performance tests which consist of pictures mounted on thin board with parts cut out, or of blocks of various shapes which must be placed in proper forms (Figure 82), have been standardized by the use of children at different age levels.[3] The norms thus estab-

[1] Hunter, W. S., "The Relation of Degree of Indian Blood to the Score on the Otis Intelligence Test," *Jour. Comp. Psych.*, 1922, Vol. II, p. 257.

[2] Valentine, W. L., "The Minnesota Stenquist Test of Mechanical Ability," a movie film prepared at Ohio State University.

[3] Pintner, R., and Paterson, D. G., *A Scale of Performance Tests*, New York, D. Appleton and Company, 1917.

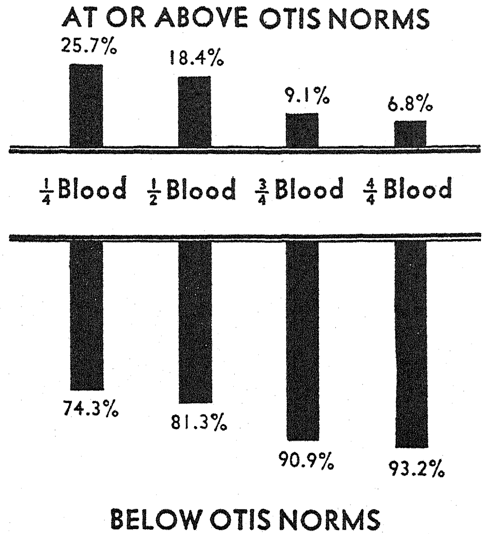


**Figure 81.—Per Cents of Indians Testing At or Above and Below Otis Norms.** (*Hunter.*)

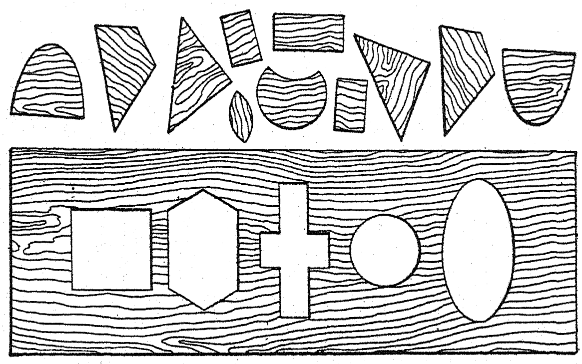

**Figure 82.—The Five-Figure Form Board.** (*After Pintner and Paterson.*)

lished are generally in terms of the time required to fit the blocks into place or the number of errors made. Figure 83 illustrates the norms for a group of children

ranging in age from 4 to 15 years. The heavy line represents the median time; the upper and lower finer lines, the 25 and 75 centiles, respectively. It will be seen that this test might differentiate performance levels at the ages of 5 to 8 or 9 years, but little difference would be expected in the later years.

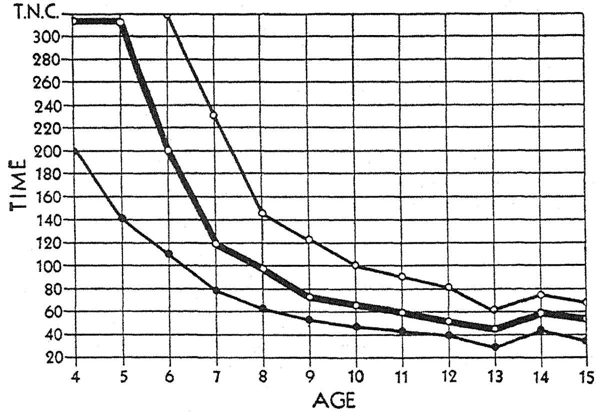


**Figure 83.—Norms in Seconds for the Five-Figure Form Board.** (*Pintner and Paterson.*)

**Tests of special performance.** It is frequently desirable to have a test which will measure some specific attainment, such as quickness of reaction, ability to discriminate colors or tones, the rate of learning, and the speed and accuracy with which certain tasks can be accomplished. Psychological tests, as they first appeared in this country, were designed along these lines. Cattell, in 1894, instituted the first psychological examination of freshman college students at Columbia University by tests of this character. Whipple has published in his *Manual of Mental and Physical Tests* (1910) a variety of these special tests with the distribution of scores for a group of subjects.

Tests for special attainment with reference to certain types of performance, such as vocational aptitude, are also frequently devised. Here the usual method is first to analyze the performance that will be required, then to devise a group of tests which will presumably measure several of the factors involved, and finally to apply these tests to a group of individuals whose performance is already known.

**Musical talent.** The development of such tests is illustrated by the studies of musical talent which have been made by Seashore and his students. An analysis of musical performance indicates that some of the qualifications are: accurate discrimination of slight differences in pitch, tonal memory, discrimination of time and rhythm, acuity of hearing, and so forth. Such an analysis is not necessarily complete. There may be other factors which help to make a good musician that are not identified. Seashore merely claims that, insofar as these qualities are factors in what we call musical talent, their measurement ought to furnish data for the prediction of musical performance or musical appreciation.

The results for two subjects are shown in the charts of Figure 84. The scores are given in centile rank. Thus, a rating of 90 means that only 10 per cent of the individuals tested did better than this one. The first chart presents the rank in the various tests of a young man who has always wanted to study music but who has been discouraged by his family, presumably on the ground that music is not a manly art. The second chart is that of a young woman who has not profited by her extensive musical training. The first subject evidently ranks very high in many of his tests and is seriously deficient in only rhythm, acuity, and training; while the second subject,

in spite of her great training, ranks considerably below average in nearly all of the tests.

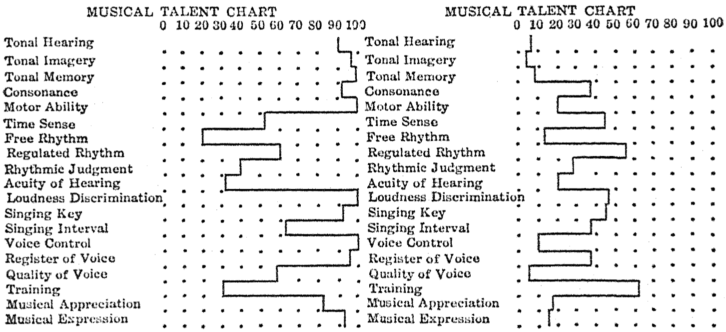


Figure 84.—Charts of Musical Talent. (*Seashore.*)

## Questions for Review

1. What types of tests may be given to groups of people? What are the advantages and disadvantages of group testing?

2. Briefly describe some of the parts of the Army Alpha test. When a group test of intelligence is being constructed, what type of items should be included?

3. Of what importance is speed as a factor in intelligent behavior? Make a careful survey of your friends or of the members of the class and determine the proportion of "slow but sure" individuals in the group.

4. What were the results of the Army Alpha test as to occupational and racial differences? What limitations are placed on the interpretation of these results?

5. Outline a testing procedure that you believe must be followed in order that differences between races in test scores will represent true racial differences in the factor that you are measuring.

6. What are some of the uses of special attainment tests?

7. What do the tests of musical ability indicate regarding the validity of considering special abilities hereditary "unit characters"?

8. Outline a mechanical aptitude test in which you would expect women to receive higher scores than men.

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Schwesinger, Gladys C., *Heredity and Environment*, New York, the Macmillan Company, 1933, pp. 58–72; 46–49; and 175–268.

## CHAPTER XXIX

# Statistical Interpretations

**The distribution of attainment.** The distribution of scores made by 2,400 college freshmen in a test which contained a large number of items is shown in the frequency curve in Figure 85. From this distribution we may determine the attainment of an individual by reference to the attainments of a group of individuals. The scores are indicated along the base line and the number of individuals for each score is represented by the perpendicular distance, the height of which is proportional to the number making that score. It will be seen that this curve conforms fairly closely to the normal distribu-

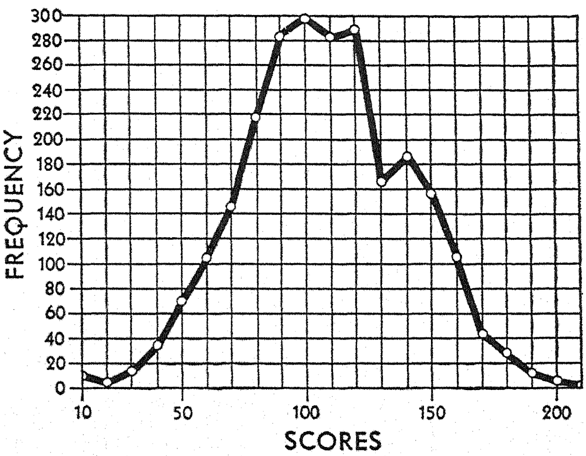


**Figure 85.—Curve Representing the Frequency Distribution of Scores Made by 2400 College Freshmen.**

tion curve which is shown in Figure 86. The greatest number of individuals received scores of 100. This point in the curve is generally spoken of as the *mode* (determined by inspection). In the theoretical normal distribution, the mode and the mean would be the same. The number of individuals receiving any particular score are fewer the farther they score on either side of the mode. Those receiving an extremely low score, 20 to 29, or an extremely high score, 190 to 199, are very few.

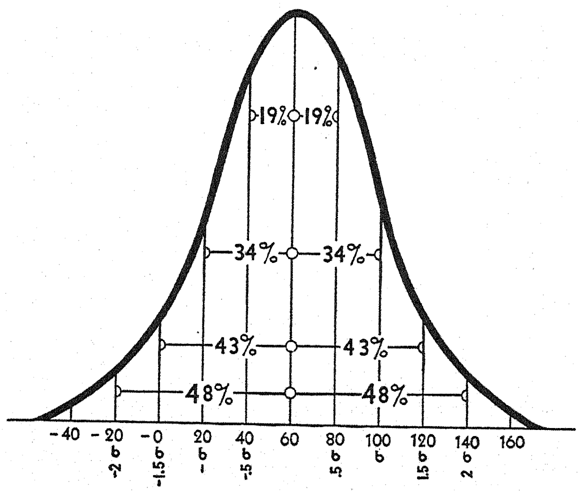


**Figure 86.—Normal Frequency Curve.**

**Standard deviation.** On the basis of such a distribution, we may classify the score of any individual by its relation to the number of individuals who might secure that score. To facilitate such a classification, the standard deviation is often used. This is obtained by determining first the mean score of the group and then the deviation of each score from this mean. These deviations are squared and the square root of the mean

of the squares obtained. This is represented by the equation

$$\sigma = \sqrt{\frac{\Sigma d^2}{N}},$$

in which $\sigma$ represents the standard deviation; d, the deviation from the mean; $\Sigma$, the sum; and N, the number of individual measures. This standard deviation is a representation of the degree of variation of the measures and is of statistical value. In a normal distribution, the number of individuals who fall within $1\sigma$ on either side of the mode or mean is 68 per cent of all individuals. Half of these, or approximately 34 per cent, are above this mean, and 34 per cent, below. If we include all scores that are within $2\sigma$ of the mean, 96 per cent of the scores will be included. Thus, 2 per cent are above the $2\sigma$ level, and 2 per cent are below the $-2\sigma$ level.

This method of rating the individual in performance has the advantage that, if he is to be rated on more than one performance, his relative standing with reference to the group can be easily obtained, and this measure is a more accurate representation than the raw score itself. For example, if the standard deviation is small, the individual scores are less scattered, but the $\sigma$ score will indicate the relative position of the individual score with which we are concerned.

Let us assume that the individual score is 70 in one test and 80 in another. Let us assume further that the mean in each case is 60. Has the individual done better in one test than he has in another? If the standard deviation is 20 in the first test and 40 in the second, his rank will be $.5\sigma$ above the mean in each test, and, therefore, he has done equally well in each test *in comparison with the others in the group.*

**Centile distributions.** Another method of determining the relative position of the individual with reference to the group is to arrange the scores from the highest to the lowest in rank of order and then set them off into 100 equal groups, 1/100 of the measures falling into each group. The points of division between successive groups in such a distribution are known as *centiles* and number from 1 to 100, 1 representing the point below which no score is found and 100 the point above which no score is found. It is then possible to indicate a score of a single individual by designating the point to which it lies nearest as his centile or percentile rating. The median point in such a distribution would be 50 centile.

Thus, we usually find students' scores in freshman psychological tests ranked in centiles. An individual is spoken of as being in the upper 95 centile, or in the 50 centile, and so forth.

The disadvantage of this method is that these steps are not equal when we consider the entire group as setting our standard of measurement. As we can see by a glance at the curve of Figure 86, a very few individuals receive an extremely low score while a great many individuals receive the mean score; and, again, very few individuals receive the extremely high score. The highest score would have to be at a greater distance from the next highest score than one score was from another in the middle range, if we were to base it on the number of individuals who make this particular score.

## The Correlation of Tests

**Scatter plots.** The inspection of individual test scores and their comparison with known performances are only a rough index of the reliability of the test as a measure

of prediction of the similarity of performance in the two situations. If a subject attains a certain score in the test, to what extent does this ensure that he will reach the same degree of success in the performance required? One of the simplest methods of showing the correlation between two performances is by means of the "scatter plot" (Figure 87). This shows the distribution of 115 freshmen according to their centile rank on the Ohio State University Psychology Examination, on the horizontal axis, and according to the point hour ratio, or academic standing for the first two quarters of the year, on the vertical axis. Thus, a student whose point hour ratio falls within the range .25 to .49 and whose centile rank is within the range 19 to 24 will be checked in the

Centile Rank

| Point Hour Ratio for First 2 Quarters | 1 - 6 | 7 - 12 | 13 - 18 | 19 - 24 | 25 - 30 | 31 - 36 | 37 - 42 | 43 - 48 | 49 - 54 | 55 - 60 | 61 - 65 | 67 - 72 | 73 - 78 | 79 - 84 | 85 - 90 | 91 - 96 | 97 - 100 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.75 - 3.99 | | | | | | | | | | | | | | / | | | // | 3 |
| 3.50 - 3.74 | | | | | | | | | | | / | | | | | | | 1 |
| 3.25 - 3.49 | | | | | | | | | | | | | / | | / | | | 2 |
| 3.00 - 3.24 | | | | | | | | / | | | / | / | | // | / | // | | 8 |
| 2.75 - 2.99 | | | | | / | | / | | // | | | / | | | // | / | | 8 |
| 2.50 - 2.74 | | | | | / | | | / | / | | / | / | / | | //// | | // | 12 |
| 2.25 - 2.49 | | | | | | // | // | // | //// | | | // | / | | // | /// | | 18 |
| 2.00 - 2.24 | | /// | | /// | // | // | // | | // | // | | /// | / | / | // | | / | 24 |
| 1.75 - 1.99 | | / | | /// | | | // | // | / | / | / | / | | | | | | 12 |
| 1.50 - 1.74 | | | | // | / | / | | | // | / | | | | | | | | 7 |
| 1.25 - 1.49 | | // | | / | | // | / | /// | | / | | | | / | | | | 11 |
| 1.00 - 1.24 | / | // | | | // | | | | | | | / | | / | | | | 7 |
| .75 - .99 | | | | / | | | | | | | | | | | | | | 1 |
| .50 - .74 | | | | | | | | | | | | | | | | | | |
| .25 - .49 | | | | / | | | | | | | | | | | | | | 1 |
| 0 - .24 | | | | | | | | | | | | | | | | | | |
| Totals | 1 | 8 | | 11 | 7 | 7 | 8 | 9 | 12 | 5 | 4 | 10 | 4 | 6 | 12 | 6 | 5 | 115 |

**Figure 87.—A Scatter Plot of the Point Hour Ratios and Centile Ranks of 115 Freshmen.**

second row from the bottom for point hour ratio, and in the fourth column for centile rank.

There is a tendency for those who are in the upper centile ranks on the tests also to be in the upper ranks in academic success. In other words, the general trend is upward in the scatter as it moves to the right. However, there is considerable variation from this. If there were no exceptions, and if an increase in one variable were paralleled by a corresponding increase in the other, the scatter would be in the form of a straight line. We would then say that there was a perfect correlation between the two variables. On the other hand, we frequently find little or no relationship between the two variables. In that case, there is no trend in the scatter. Or, we may find that the scatter shows a downward trend: the better the performance in one test, the poorer the performance in the other. The scatter plot gives us a better notion of the relation between two test performances than can be obtained by inspection of a few isolated cases.

TABLE XVIII

THE RANK ORDER OF TEN SUBJECTS IN TWO TESTS

| *Subj.* | *Test 1 Rank* | *Test 2 Rank* | *Difference* d |
|---|---|---|---|
| A | 1 | 2 | 1 |
| B | 2 | 4 | 2 |
| C | 3 | 1 | 2 |
| D | 4 | 3 | 1 |
| E | 5 | 5 | 0 |
| F | 6 | 6 | 0 |
| G | 7 | 8 | 1 |
| H | 8 | 9 | 1 |
| I | 9 | 7 | 2 |
| J | 10 | 10 | 0 |

**Coefficient of correlation.** For greater accuracy, certain formulae which state the relationship in terms of quantities between 0 and 1, or –1, are used. One of the simplest formulae to understand is based upon the rank differences of the subjects scored. Let us suppose that Table XVIII represents the ranks of 10 subjects in two tests. The formula to be used is

$$\rho = 1 - \frac{6 \Sigma d^2}{N (N^2 - 1)},$$

in which $\rho$ represents the coefficient of correlation by the method of rank differences; $\Sigma$, the sum of the d-squares; d, the difference in rank in the two tests to be compared; and N, the number of cases. Substituting in this formula, we have

$$\rho = 1 - \frac{6 \times 16}{10 (100 - 1)} = .903.$$

This is a very high correlation, much higher than would ordinarily be obtained between a test and some general performance, such as an intelligence test and scholastic attainment in college. The results shown in the scatter plot (Figure 87) give a correlation of .564, which is about as high as is usually obtained with such tests. In this case, the correlation was obtained by another formula, namely, the "Pearson product-moment" formula,

$$r = \frac{\Sigma xy}{N \sigma_x \sigma_y},$$

in which x is the deviation of the x-values from their mean, and y is the deviation of the y-values from their mean, and $\sigma_x$ and $\sigma_y$ are the standard deviations of the two series. The objection to the rank-difference method ($\rho$) is that it does not take account of the inequality be-

tween different ranks. Subject *B* may rank a very close second, while subject *C* may score considerably lower and yet rank third. By the product-moment method, these differences are taken into account.

**Probable error of correlation.** When we have the correlation between two measures, we may want to know what the probability is that this is a correct estimate of the degree of similarity between them, that is, what the probability is that this result would be obtained with another group or with the same group under identical conditions. We may determine the probable error of r by the formula

$$PE_r = .6745 \frac{1 - r^2}{\sqrt{N}}.$$

Applying this formula when r = .564, we find that the probable error is ± .043. Thus, our correlation reads, r = .564 ± .043. It will be seen that the probable error will be less if we use more subjects, or if the value of r increases.

**The interpretation of correlation coefficients.** When we have obtained a coefficient of correlation, let us say r = .564 ± .043, we wish to know just what it represents. In the first place, we have applied a test of unknown reliability and then compared the results with scholastic success in order to determine whether the test would predict this kind of success when applied to another group. The point hour ratios serve as our *criterion.* If now we apply this test to a new group of freshmen, to what extent could we predict their success in the same courses and under identical conditions?

Again, mathematical calculations will tell us. Prediction formulae indicate how many individuals may be expected to fall within any specified group in scholastic

standing and what the corresponding group in the psychological test is. Table XIX shows the prediction value of various degrees of correlation when the criterion

TABLE XIX

SHOWING FOR VARIOUS DEGREES OF CORRELATION AND COARSENESS OF CRITERION SCALE THE NUMBER OF INDIVIDUALS ACTUALLY FALLING WITHIN ½ POINT OF WHERE PREDICTED. THEORETICALLY PERFECT DISTRIBUTIONS ARE ASSUMED. (Hull, *Aptitude Testing*, p. 265.)

| r | COARSENESS OF CRITERION SCALE | | |
|---|---|---|---|
| | *10 points* | *5 points* | *3 points* |
| .00 | 16% | 31% | 50% |
| .40 | 17 | 34 | 53 |
| .50 | 18 | 35 | 56 |
| .60 | 20 | 38 | 59 |
| .70 | 22 | 42 | 65 |
| .80 | 26 | 50 | 73 |
| .90 | 35 | 64 | 87 |
| .95 | 48 | 80 | 97 |

is divided into 10, 5, or 3 grades. As psychological tests usually correlate about .60 with academic success, and as scholarship grades usually range in five grades from *A* to *E*, we can see that a student making an *A*-grade standing on the test has 38 chances in 100 of an *A* in college, as is shown in the third column.

Table XX gives a more comprehensive arrangement of the possibilities. If we divide the students into 10 groups according to test performance, and do likewise for scholarship attainment, we see what variations are to be expected when $r = .60$. A student who is in the third group or decile on the test has fourteen chances out of 100 of being in the first decile in scholarship, sixteen chances of being in the second decile, fifteen of being in the third, and only two chances of being in the tenth decile. On the other hand, a student in the

ninth decile has only once chance of rating in the first decile on scholarship and twenty chances of being in the lowest decile.

TABLE XX

INTERPRETATION OF CORRELATION COEFFICIENT OF r=.60
(Burtt, *Employment Psychology*, p. 215.)

| r=.60 | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 39 | 20 | 14 | 10 | 7 | 4 | 3 | 2 | 1 | 0 |
| II | 20 | 19 | 16 | 13 | 10 | 8 | 6 | 4 | 3 | 1 |
| III | 14 | 16 | 15 | 13 | 12 | 10 | — | 6 | 4 | 2 |
| IV | 10 | 13 | — | 13 | 12 | 12 | 10 | 8 | 6 | 3 |
| V | 7 | 10 | 12 | 12 | 13 | 12 | 12 | 10 | 8 | 4 |
| VI | 4 | 8 | 10 | 12 | 12 | 13 | 12 | 12 | 10 | 7 |
| VII | 4 | 6 | 8 | 10 | 12 | 12 | 13 | 13 | 13 | 10 |
| VIII | 2 | 4 | 6 | 8 | 10 | 12 | 13 | 15 | 16 | 14 |
| IX | 1 | 3 | 4 | 6 | 14 | 10 | 13 | 16 | 19 | 20 |
| X | 0 | 1 | 2 | 3 | 4 | 7 | 10 | 14 | 20 | 39 |

## Questions for Review

1. What are some measures of central tendency? Describe briefly the steps to be followed when each of these measures is being obtained. Of what value is a measure of central tendency?

2. What are some measures of variability? How are they found? What do measures of variability indicate regarding the data from which they are calculated?

3. What is the advantage of expressing a score in terms of standard deviation units from the mean of the group? Give some everyday situations in which this procedure may be used to advantage.

4. What interpretation is placed on a centile rank of 89? How would this standing be expressed as a decile rank; a quartile rank? What are the advantages of expressing attainment scores in terms of centile rank?

5. How may we interpret a coefficient of correlation? What does a coefficient of –1.00 mean; one of 1.00?

6. Between what variables as they occur in nature would you expect to find a perfect (negative or positive) correlation? Does such a correlation actually exist between these variables?

7. What does the difference between the actual correlation obtained from some given data and a perfect correlation indicate?

8. With what other variables must the results of an "intelligence" test correlate rather highly in order for that test to be really a test of intelligence?

### References

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# SECTION XI. SOCIAL ADJUSTMENT

XXX. Social Behavior
XXXI. Experiments in Social Behavior
XXXII. Personality

References to Student's Guide:

Exercise 104. Analysis of the Dependence of the Individual upon the Group
Exercise 105. The Judgment of Intelligence from Motion Pictures
Exercise 106. The Judgment of Facial Expression
Exercise 107. The Graphic Rating Scale
Exercise 108. Social Facilitation of Performance
Exercise 109. Construction of an Attitude Scale
Exercise 110. Administration, Scoring, and Interpretation of an Attitude Scale
Exercise 111. An Annoyance Rating Scale
Exercise 112. An Analysis of Annoyance
Exercise 113. A Study of Nationality Preference (Paired Comparisons Method)
Exercise 114. An Analysis of Prejudice
Exercise 115. Color Preference—Personal Reactions
Exercise 116. Verbal Affective Responses to Isolated Major and Minor Chords
Exercise 117. Conformity Behavior

## CHAPTER XXX

# Social Behavior

We have from time to time referred in the preceding chapters to the distinction between the physical environment and the social environment. Because an organism is reacting according to its own structure and to the environment in which it lives, we say that such behavior is directly mediated between the organism and his physical environment, and is therefore biophysical. In cases in which his reactions are due to the stimulation of other individuals, we say that it is biosocial. Though all social stimuli, in so far as they act on receptors, are physical, the fact that the individual can react to these, not as simple physical stimuli, but as interpretations of another individual, indicates that they are social in character.

**Social behavior in lower animals.** The human species is outstanding in the greater development of its social behavior as compared with that of the lower animals. This does not mean that there is no social behavior among lower vertebrates, or even among the invertebrates. Here, however, it is of a much lower order and is less important in comparison with the physical influences than that in the human being. Anyone may observe a school of small minnows along the shore, all swimming in one direction; suddenly, one changes its course, and all the minnows follow. This behavior may be due to the stimulation of the other minnows by the movements of one. We see the same characteristic in a covey of quail

or in a brood of young chickens. The behavior of wild animals in the herd is also social. It is usual for biologists to think of this behavior as innate or instinctive. This does not alter the fact that the behavior of one animal is a stimulus for the behavior of another. One chick screeches and runs, and all the chicks run.

Extensive observations on the social behavior of roosters have been carried out. For example, 4 roosters that were in the same pen manifested the following characterictic reactions with reference to each other. Rooster *A* picked a fight with and licked *C*, whereupon *B* fought *C* with similar success. *B* then picked a fight with *A*, but was defeated. Later *A* fought *D* and was successful, but *B*, since his defeat by *A*, would not fight *D*. This is a considerably abbreviated description of the relations between these 4 animals, but it serves to illustrate a simple form of social behavior. Rooster *B* followed the example of *A*, but failed to discriminate between the prowess of *C* and *A*. Also, the defeat by *A* carried over to *D*, whom *B* refused thereafter to attack.

**Human social behavior.** When we look at the progress of man and try to estimate the influence of the social factors in his present-day development, we get quite a different picture. Though the difference in biophysical behavior between man and the lower animals is great, the distinction on the biosocial level is outstanding. Man has been able to acquire new modes of behavior, possibly from observation of other animals, particularly those most nearly resembling himself, as well as from the observation of other men. This behavior becomes the heritage of the next generation through its learning it from the parents. Later, the discoveries are made permanent in the form of weapons, utensils, and records—that is, pictures and crude writing. In this way is built

up a culture consisting of specific modes of living, art, beliefs, social customs, and so forth.

**A hypothetical case.** Let us suppose a group of individuals of the type who are now in college, except that they are isolated in some corner of the earth with absolutely no knowledge of other individuals, are brought together for the first time. These "Adams" and "Eves" know nothing of the inventions of weapons, cooking utensils, and the like.

Their first problem will be the adjustment of one individual to the others. They must also hit upon new methods for providing the necessities of life. Language and art, the manufacture of tools, and the discovery of metals and their treatment are all before them. Our first thought might be that all of these would be discovered in the course of a single life span, yet in all probability it would take hundreds of years to attain the stage of civilization reached by the Aztecs or the Mound Builders of the wild West. We can see from such a picture that civilized man is dependent for his behavior upon a mass of material which is due to social development of the group throughout the ages.

**Common factors in isolated groups.** We may expect that our hypothetical group will, however, develop certain modes of behavior which are very much like those of the primitive peoples of today and of those of prehistoric and ancient times. For example, weapons in the form of crude axes and spears will be fashioned. Later, weapons of metal will be devised. Pottery and some kind of fabric will also be developed. Art will include some forms which are found in various parts of the earth among peoples who are, undoubtedly, completely isolated.

For example, the swastika was found in ancient Egypt and in the mounds of the prehistoric Mound Builders of

America. The cross as a religious symbol was used in ancient Mexico before white men arrived. The practice of cutting off the little finger might also be found, as it is among primitive and prehistoric peoples in practically all parts of the world. Not all of these symbols can be satisfactorily explained, but they are doubtless due to certain characteristics common to the human species which lead to the development of certain forms and practices.

Some of the influences at work in widely distributed and isolated groups are the human form, common physiological conditions—such as hunger, temperature changes, and sex—and the inadequacy of the adjustments to the physical and social environment. Man is what he is and develops as he does because of his anatomical structure and his environment. His structure, his limitations in strength as compared with those of some animals, his need for covering for the body, and so forth, lead to certain characteristic modes of response, such as the use of the hands and vocal organs, facial expressions, and walking upright.

So much for our hypothetical group and our prehistoric ancestors. Archeologists have found clear evidence that interest in the human figure and in primitive human activities has led to similar symbols among widely separated peoples. The sun, wind, storms, and so forth, have also been common and have likewise played a rôle in cultural development. We will succeed better, perhaps, by an analysis of some of the factors in present-day human social behavior.

**Social stimulation and response.** The most immediate, or *primary,* stimulations are those of physical forces. Light, temperature, movement, and vibrations, as changes in the physical environment, result in reactions which are

equally direct or primary. When, however, a reaction to a situation which serves as a more indirect stimulus for another individual is developed, it takes on social significance. Such secondary stimuli are in the nature of signals. One may approach and strike another; this stimulation may result in any one of several responses. Later, a frown, gesture, posture, or vocal response may constitute a threat which elicits the same response. Social stimulation and response are, therefore, conditioned by previous experience with more or less primary stimulation.

The response also becomes *secondary,* or social, in the sense that we may not strike when threatened, but may substitute a more indirect defense response, such as a verbal threat or a posture of superiority. When further elaborated, the reactions of one individual are stimuli to other individuals in a great variety and complexity of situations. The basis for this type of development is the experience and learning of the individuals concerned, and the acuteness of their discrimination in social situations.

**Facial expression.** Man differs from the lower animals both in the complexity and the variety of the responses of the facial muscles. If we watch a friend, we say that he is angry, pleased, disgusted, interested, perplexed, attentive, startled, doubtful, defiant, anxious, meditative, or the like. Evidently, the facial behavior is of a variety of forms. We have learned to interpret these expressions. There have been reciprocal stimulation and response between individuals which testify to the fact that not only does man express his behavior in facial contractions, but he is also able to learn to discriminate these responses in another.

A number of investigators have studied facial expres-

sions by presenting to a group a number of photographs of the same individual with the instructions that they are to identify the expression. In most cases, these have been labeled "expressions of emotion." If we remember that emotion, strictly considered, is merely the breakdown of organized response, that not all of the so-called emotions are strictly emotions but are different types of organization, and that they are more specifically forms of reaction to the situations produced, we may consider these experiments as experiments in social stimulation through facial reactions.

To secure these pictures, the investigators used an individual who had some training in the interpretation of the reactions to various situations. She posed, for example, for the interpretation of apprehension, fear, or sorrow. The group of subjects who were to identify the situations were furnished with a list of some 30 situations of this type. With adult subjects it was found[1] that there was a fair degree of accuracy in identifying the picture with the situation that it was designed to portray. The same method has been applied in studying the ability of young children to identify facial expressions from photographs. It was found that they could not identify the situations so accurately as the adults had done. This would lead to the conclusion that we learn to identify facial reactions with specific situations.

**Emotional expression of infants.** On the other hand, Mandel Sherman[2] presented real situations of young

[1] Feleky, A. M., "The Expression of Emotions," *Psych. Rev.*, 1914, Vol. XXI, pp. 33–41.

Langfeld, H. S., "The Judgment of Emotions from Facial Expression," *Jour. Abn. Psych.*, 1918, Vol. XIII, pp. 172–84.

Ruckmick, C. A., "A Preliminary Study of Emotion," *Psych. Mono.*, 1921, Vol. XXX, No. 3.

[2] Sherman, M., "The Differentiation of Emotional Reactions in Infants," *Jour. Comp. Psych.*, 1927, Vol. VII, pp. 265–84; pp. 335–351.

infants. The group of subjects was shown motion picture films of an infant who had been stimulated by hunger, by being dropped, by restraint, or by being given a painful stimulus. There was considerable lack of agreement in naming the reactions, in spite of the fact that students of psychology, nurses, and medical students, who might be expected to have some knowledge of infants, were used as observers.

The conclusions that we may draw from these experiments are:

1. Pictures of reactions to situations give a partial index of the reaction when adults are used as observers.

2. Children are less adept at identifying the situations, presumably because they have not yet attained the discriminative ability reached by the adults.

3. Infants under 12 days of age do not react as differentially as adults.

**Important elements in expression.** It is also interesting to consider what part of the face plays the most important rôle in social stimulation. It has long been assumed that the eyes are the expressive part of the face. "Sie kennen die Augen" is an old German saying. Children are supposed to be able to discriminate the character of strangers by the expression of the eyes. We say that a person has "a mean eye" or "a kindly eye."

Dunlap [3] photographed several subjects under a variety of situations, such as a sudden loud noise, an electric shock, an interesting picture, pain, and so forth. These pictures were then cut horizontally just below the eyes and the upper half of one picture attached to the lower

[3] Dunlap, K., "The Role of the Eye-Muscles and Mouth-Muscles in the Expression of Emotions," *Genet. Psych. Mono.*, 1927, Vol. II, pp. 195–234.

half of another. Judges of these new pictures more frequently identified the situation belonging to the lower half than that belonging to the upper half. Thus, if the upper half of a picture taken during an agreeable situation was attached to the lower half of one taken during a painful situation, the judges pronounced the new combination as an expression of pain.

That facial reactions are not alone the expression of emotion is shown in the pictures in Figure 88. The

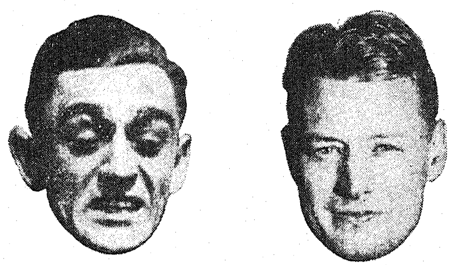

**Figure 88.—Facial reactions.** The man at the left is finishing the hundred-yard dash. The man at the right is suffering severe pain.

picture on the right was taken while the subject was being pinched with a pair of pliers. The one on the left was taken during great physical effort, near the end of the hundred-yard dash. It will be seen that either could be interpreted as representing the other, or some other situation. In order to interpret facial expression, it is helpful to know other features of the situation.

**Minimal cues.** We frequently react to the entire situation without being able to identify specific elements which are the essentials in the stimulating situation. Some other characteristics that serve as stimuli are slight movements—changing or shifting positions of the head and other parts of the body—some of which can be identified and some of which are sufficiently slight that ordi-

narily one cannot observe them even by close inspection.

A good example of these minimal cues is shown in the so-called "mind reading" exhibitions. The favored method is for the performer to leave the room while some object is hidden by one of the group. The performer is then brought in blindfolded and takes the hand of the one who has hidden the object. Apparently, the blindfolded performer leads the other to the object. Actually, what happens is that the performer is led to the object by the other person. Such experiments are illustrations of muscle reading, or of reaction cues.

There are many instances in everyday life in which these minimal cues are functioning. We say that we have made some progress in presenting our point, though there is no definite reaction on the part of the one influenced which can be identified. Each responds favorably or unfavorably to the other in such a vague fashion that neither identifies the particular reactions. We get along well with some individuals, and not so well with others. One man may make you feel inferior, and yet he has been perfectly cordial and sympathetic. There has been nothing to which you can point that indicates that he maintains a superior attitude or disrespects your view.

## Language

We may define language as any symbolic behavior of an individual which serves as a secondary stimulus to another person. This behavior may be in the form of signals with the hands, arms, and other parts of the body; or of less direct signaling, such as the smoke signals of the Indians; of facial expressions; or of spoken and written verbal types of response. The early forms of language used by the young infant and by primitive

peoples are postures and gestures. Before the infant can use verbal means of stimulating other individuals in his environment, he has already learned to employ various types of behavior for the same purpose, such as holding out his arms, wiggling, and crying.

**Theories of verbal language.** A number of theories have been presented to explain the origin of spoken language. Presumably, each is partially correct, but no one of them is able entirely to account for the whole field of language development. The structure of the individual must have a predominating influence in the development of sounds which later become organized as language habits. Because those structures which are intimately connected with verbal response are common to the whole human race, we would expect some words to be common in those groups that live under similar conditions. The young infant in his random vocalizing hits upon such sounds as "dada" and "mama." These are usually repeated, not necessarily in pairs, but as "dadadada" or "mamamama." With slight variations, we find these two words rather common in the languages of various countries where the family is the social unit. These may be illustrative of numerous natural vocal sounds which play an important part in many languages.

One of the theories of the origin of language is known as the *onomatopoetic* theory, which assumes that the first words resemble in sound the things which they represent, for example, *bumble, boom,* and *cough.* In many instances it is doubtful whether the word actually resembles the sound or has become so intimately associated with the situation that we neglect to note the differences.

A second theory is that language developed out of sounds made by the individual under specific conditions.

Thus, in the strain of lifting a heavy object, a man emits certain grunting sounds. If he is surprised, the reaction includes an expulsion of air which gives a sound such as "ah." If a man is overcome by the enemy, as he collapses he ejects a sighing sound. This is known as the *interjectional* theory.

No doubt, each of these theories partially explains the origin of certain words, but neither theory alone is adequate. Furthermore, many words are hit upon accidentally in random vocalizing and are associated with certain objects or situations and thereby become established as habits.

**Common experience necessary for language.** It is fundamental to the development of language, if it is to have social significance, that both individuals, the stimulator and the one stimulated, shall have had the same or similar experiences in the development of the use of the word. We have already seen in Chapter IV that the word must be conditioned to the situation in which it is used in order to be classed as language. The child sees milk; he hears the word *milk*. He drinks milk and again hears the word, and so on, until *milk* has been definitely established as a symbol for a particular thing.

The same is true of such words as *honor* and *virtue*. One may use the word *honor*, but the stimulus to the other individual may be quite different from what is expected, simply because the training of the two individuals in situations in which this word was used has been quite different. Such differences are responsible for many misunderstandings between one individual and another.

**Accuracy of language habits.** A second factor of fundamental importance closely related to the common

experience of the two individuals is the degree of discrimination of which each is capable. We frequently get into difficulty in ordinary conversation because the finer distinctions which the speaker wishes to make are not observed by us.

Therefore, while language is of very great importance in the development of social behavior, it also has its limitations because of the varying degrees of similarity and difference in the experience of the individuals using the same terms, and further because of the fact that the same terms frequently have many meanings or have been applied to numerous situations which are not identical.

It is the aim of science to define its terms as accurately as possible with reference to the concrete situations with which the scientist deals. This ideal is not always attained because of the background of previous experiences in which the terms have been used. The student has already met with numerous difficulties in the way of using language because many of the terms are similar and yet have been loosely applied to various types of situations.

In spite of the inaccuracy of our language habits, they are of great importance to us in meeting concrete situations. For example, it would be extremely difficult for the student in psychology to get very far in acquiring the knowledge he already possesses regarding human behavior if no language had been used, even though he failed many times to distinguish between the use of terms and their real significance or the facts which they symbolize. The greater amount of his learning has been in terms of words which were already a part of his vocabulary and which possessed significance for him because of his previous experience with them.

**Concrete to abstract.** We frequently go on from the concrete situations which are analyzed or dealt with in terms of language and use language to deal with new situations which do not exist. Take, for example, the mathematical expressions with reference to experiences. The mathematician may let the letter $a$ represent the length of a given line; $a^2$ will then represent the square and $a^3$ will represent the cube of sides of the dimension $a$. So far, the language of the mathematician has represented concrete situations. He may go further, however, and write $a^4$ and $a^5$, for which there are no concrete situations. Also, we may say that we have four colors: red, yellow, green, and blue. A mixture of red and yellow produces a red-yellow. Yellow and green produce a yellow-green, but red and green cannot produce red-green, though we may be able to make the verbal combination.

There are many other situations with which we are able to deal through the use of verbal terms. The greater part of philosophy is a manipulation of words which often has, like the mathematical expressions above cited, gone beyond the possibilities of any concrete situation. The real value of philosophy lies in the fact that it does usually deal, through the use of language, with the data of science and human experiences. It also originates new terms which are virtually conditioned with other terms originally conditioned with concrete situations. In this way we are able to extend our knowledge by constructing out of our concrete experiences new forms. We must be certain, however, that we have not neglected any of the relevant, concrete data.

**Mathematics as language.** Perhaps the highest development of language is reached in mathematics, which is essentially the language of science. The reason why mathematics is difficult for most of us is that it is

accurate. It is useful because one can, when he has mastered the vocabulary and syntax of mathematics, express more exactly what he means. The stimulus to the "other one" must be what is desired, provided he understands this language.

Through mathematics there can be met many concrete situations that could not be treated in any other way. Einstein's theory of relativity is an excellent example. Many scientists have attempted to explain it to the uninitiated, but it simply cannot be stated adequately in any other language, and the principles could not have been evolved by any other language. Likewise, many of our modern inventions are the result of mathematical treatment. The forecast of business cycles, the prediction of population increase, and other statistical problems involve mathematics as the tool for "talking" about them.

**Recorded language.** We have gradually in this discussion slipped over from the simple man-to-man stimulation and response to the more complicated forms of social interstimulation which involve language in the written and printed form. Here the stimulation is more remote in that the response of the writer may be a stimulus to another at some later date. The latter's reaction may not be a stimulus to the former, but it may stimulate other individuals.

Our present social culture is due not merely to the behavior of earlier generations, handed down from one generation to another, but to that earlier behavior which was made permanent through writing. We are influenced by the ancient Egyptians through their crude writing, while the only influence left by the Mound Builders of America is their mounds of earth and a few relics of pottery and simple implements.

## Social Traits

**Preferences primarily social in origin.** It is a common assumption that many of our preferences, such as those for colors and certain combinations of tones, and our distinction between pleasant and unpleasant odors, are inherent in the organism; that is, they are innate or inherited characteristics of the race. The experimental findings, particularly with colors without reference to the objects reflecting the colors, indicate that there is no basis for this assumption.

The young infant "prefers" yellow to the other colors, but his preference is evidently due to the fact that he reacts more readily to bright colors than to the darker ones. Certain colors are preferred by adults because they have been experienced in connection with objects, or in situations, in which arose a particular type of response. Many times, the origin of these preferences cannot be identified.[4] An individual prefers blue—books with blue covers, blue clothes, blue automobiles. These are undoubtedly preferred because blue was most often associated with situations in his early experience which would be described as pleasant.

**Appreciation of music.** The same is true of musical forms. When we listen to Oriental music, we fail to understand why any people would consider it musical. Chinese music is nothing but noise. This reaction is partly due to the fact that the musical intervals are not the same in Chinese and other Oriental music as they are in our Occidental music. If we could hear the Oriental music more frequently, we would gradually learn

[4] Dorcus, R. M., "Color Preferences and Color Association," *Ped. Sem.*, 1926, Vol. XIII, pp. 399–434.

to appreciate it very much as we have learned to appreciate our own.

A group of students was presented with three records of high-class Chinese music. A Chinese student who was familiar with Chinese music made the selections and vouched for their high quality. One was the "Worship of Spring," another represented sadness, and the third was a love scene. When these records were played in succession, the students declared that they were all alike and nothing but noise. They were then told what each represented, but not which record corresponded to each type of music. The records were again played several times in different orders. After several such repetitions, more than half of the class could identify all three.

People who have lived a long time in China learn to appreciate Chinese music and art, including the peculiar color combinations. Even the peculiar odors of a Chinese market, which are so offensive to the Occidental, lose their disagreeable character for those who have long lived in a Chinese environment.

Social training also determines our preference for certain types of furniture, dress, and food. The furniture of the Victorian period had its vogue, but we are now getting away from this gingerbread type of ornate decoration. We need to go back only a generation to find styles of clothes which to us now appear unesthetic and ridiculous.

**Food preferences.** Stefansson, the Arctic explorer, gives an interesting account of the food preferences of dogs and men. He relates that the dogs he took with him from this country would eat anything placed before them, while some of the Eskimo dogs would eat only ducks. Others would refuse ducks, but would eat seal. The American dogs were more in the habit of eating a

variety of foods, while some of the Eskimo dogs were raised in a section of the country where there were ducks but no seals, and others where there were seals but no ducks. The Eskimos also manifested similar preferences, and the American foods were distasteful to them.

Many of our likes and dislikes for food are the result of social pressure. We eat salads because it is the proper thing to do, and in some cases we learn to like them. It is also questionable whether many people like tobacco at first. Smoking is indulged in because others smoke, and in time the taste is acquired. We may say, therefore, that our preferences in art, music, architecture, styles, and food are the result of our habits acquired in a society in which these particular forms exist.

**Imitation and conformity.** It has often been assumed that social development is based upon the fact that man "instinctively" imitates. This assumption has been made in an effort to demonstrate that our social development is dependent upon certain specific innate characteristics which can be thus isolated. We have already pointed out that the child learns to imitate. He sees others do what he can do, and in this way he becomes adjusted to his social environment. It is this trait of man to observe the behavior of others and react accordingly which has made him superior to the lower animals in social development.

We find that it is also true that to do as others do is more convenient and less hazardous than to depend entirely upon our own individual inclination. This fact has led to the development of the habit of conforming to the behavior of those with whom we live. It is more acceptable to grant that this is a habit which develops within the social group than to assume that there is a fundamental or innate "desire of conformity." The conformity arises through experience rather than through in-

heritance. It is an adequate social adjustment which is learned by the individual in his contact with other individuals.

**Common verbal associations.** A simple experiment illustrates the fact that not only do we adopt the same overt modes of response as our neighbors, but even our implicit verbal habits are very much the same. A group of students was told that a list of words would be read, and that, for each word, they were to recall a word of the class represented. For instance, if the words *algebraic symbol* were given, they were to write the first word of this class which they recalled. Table XXI gives the words used and the per cent of greatest frequencies for a group at Cornell University ($C$) and a group at the University of Kansas ($K$).

It is apparent that red is the most representative of the colors, and that the letter $A$ is most representative of the alphabet. Presumably, these are most frequently used as illustrations. The present author once gave this same list to students in a Southern university with similar results, with the exception that for historic personages Lee superseded Washington. Questioning showed that this did not mean that Lee was considered greater than Washington, but that he was more frequently mentioned.

**Rivalry and preëminence.** As in the case of imitation, rivalry is an important factor in the development of social behavior. For this reason it has been frequently classed as an instinct or innate characteristic and has thus been used as explanatory of those types of behavior in which one individual is directly or indirectly stimulated by another and reacts by competing for supremacy. What is really innate in this situation is that each individual has certain needs. The physiological conditions,

which we have called *drives,* create certain activities which lead ultimately to the removal of the drive.

Now, if two individuals are dominated by the same drive in the presence of each other, they may become

TABLE XXI

| *Color* | *C* | *K* | *Furniture* | *C* | *K* | *Flower* | *C* | *K* | *Letter* | *C* | *K* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Red | 57 | 69 | Chair | 68 | 80 | Rose | 45 | 56 | A | 63 | 71 |
| Blue | 53 | 16 | Desk | 12 | 9 | Violet | 15 | 5 | B | 12 | 12 |
| Green | 5 | 9 | Bed | 5 | 0 | Tulip | 10 | 0 | C | 7 | 5 |
| *Metal* | *C* | *K* | *Historic Person* | *C* | *K* | *Part of Speech* | *C* | *K* | *Geometric Figure* | *C* | *K* |
| Gold | 49 | 40 | Washington | 54 | 40 | Noun | 67 | 37 | Triangle | 54 | 47 |
| Iron | 26 | 40 | Napoleon | 10 | 12 | Verb | 16 | 35 | Square | 26 | 17 |
| Silver | 8 | 7 | Alexander | 8 | 0 | | | | Circle | 8 | 19 |
| *Verb* | *C* | *K* | *Tool* | *C* | *K* | | | | | | |
| Go | 33 | 27 | Hammer | 39 | 52 | | | | | | |
| Do | 13 | 35 | Hatchet | 10 | 10 | | | | | | |
| Be | 8 | 10 | Saw | 10 | 15 | | | | | | |

competitors. Two pups with a single bone will each become more active in the struggle for possession. In the present-day human situation, the food drive is not so clearly evident in rival situations until many other habits are formed. At an early age, however, the individual has developed the "possession habit." All things are "mine" (Chapter XII). Such habits, and the reciprocal stimulation and response with other individuals, foster the development of a habit of rivalry. Competition is necessary to earn a living, to win the mate, until, finally, to be preëminent takes on subtle forms.

The "desire for preëminence" is, therefore, a result of

social behavior. Conformity is comfortable because it avoids conflicts and strife. To do as others do, to wear the same kind of clothes, and to adopt the same forms of polite behavior save trouble. At the same time, one's "individuality" must be expressed. For most people this is merely the normal outgrowth of social situations in which getting for oneself, or satisfying fundamental drives, has led to a *habit of rivalry*. Even rivalry in games is an expression of this habit carried into playful activity.

In some cases, either the habit of imitation or that of rivalry becomes dominant to the exclusion of the other. One individual "loses his personality" because of the rigor of his conformity, while another must be preëminent. Rivalry is the dominant social habit with the latter. If he possesses the proper qualifications, he is the social leader; he is in business for the sake of the competition. If he is inferior to the others, he gains his preëminence by means of various oddities. He wears the wrong-colored clothes, or goes without a hat in a community in which hats are worn, merely to be preëminent.

**Beliefs as social heritage.** Most of our common beliefs are the result of our social heritage rather than the outcome of a direct consideration of facts. Our religious beliefs grow out of our contacts in the home and the local community. Even when we have examined the facts at a later period and reach diverse conclusions, we still generally behave *as if* the former beliefs were correct. Repeated stimulation in the early years has established the habit of reaction so that it still functions in most instances. A small boy who had lived in a home in which Santa Claus was talked about as a real person was finally told that Santa Claus did not exist, but that his father and mother gave him his presents. He accepted

the explanation as true, but continued to attribute his presents to the mythical character as a reality.

Advertising and propaganda result in similar social behavior. Repeated stimulation with the announcement that this drug has certain curative properties results in the belief that this is an established fact. Those who have read the advertisement many times will say, "they say so-and-so," meaning that some disinterested authority says so.

All of these examples emphasize the fact that our beliefs and customs, our standards of morality and ethics, are habits which are the outcome of the social environment in which we live. Only Methodists will get to heaven. The Catholic is a poor, deluded soul and the Church an instrument for overthrowing the government. The Germans are barbarians in spite of the fact that, could we read their language, we would realize the absurdity of the statement. We fail to recognize the efficacy and ideals of Buddhism because we cannot understand it. We have lived in a different world.

## Questions for Review

1. List some examples of social behavior which you have observed in the lower animals. What criterion of social behavior are you using?

2. What is the essential difference between the social behavior of man and that of the lower forms?

3. Distinguish between primary and secondary stimulation and response.

4. What evidence indicates that both the use and the interpretation of facial expression as a form of language must be learned?

5. Look for some examples of the use of minimal cues in your own experience. What are some situations in which

mimimal cues play an important part but are not remembered or reported by those using them?

6. What are some of the conditions under which an adequate language will develop?

7. What are some of the theories regarding the origin of language?

8. What makes a language accurate? What are the advantages of accurate language habits?

9. What does the available evidence indicate regarding the origin of preferences?

10. Discuss the importance of conformity and rivalry in social behavior. Are these two forms of behavior mutually exclusive, i.e., may they occur in the same individual?

11. Make a list of some of your beliefs which you hold because they have been passed on to you by the particular group in which you were brought up.

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## CHAPTER XXXI

# Experiments in Social Behavior

It is well known that we can do better when we are competing with others than we can when we are alone. A man can run the hundred-yard dash in less time if he is competing with others who can run as fast as he can. If he is running with a group who soon leave him far behind, he will not run so fast as he would with close competitors. Competition, which means that a standard is set to do a little better, is an incentive to greater effort. This effect is shown in the experiment of work with and without knowledge of results (*Student's Guide*, Ex. 32). But what is the effect of mere proximity to others who are doing the same kind of work but whose accomplishment we are unable to observe? Can a student do better work if he studies alone in his own room or in a room such as the library, where others are studying at the same time? Some prefer the one situation and some the other. Doubtless it is to some extent a matter of habits of study and personal preferences. It is also possible that some types of work can be done better under one set of circumstances while other types demand different conditions.

**Experiments in social facilitation.** Several investigators have studied the accomplishment when the individual worked alone and when he worked in a group in which all were performing the same tasks. The results, in general, have been that the individuals, on the whole,

do better when they are working with others than they do when they work at home or in an isolated place in the laboratory. Allport [1] investigated the work of college students in various types of activity. Some of these investigations included studies of attention, multiplication, and free association.

In the first tests, subjects were required to cancel the vowels in a newspaper column as rapidly as possible or to fixate a figure of reversible perspective (Figure 89). They were to look at the line *BD*, and as soon as the plane *ABCD* appeared nearer, they were to look at the

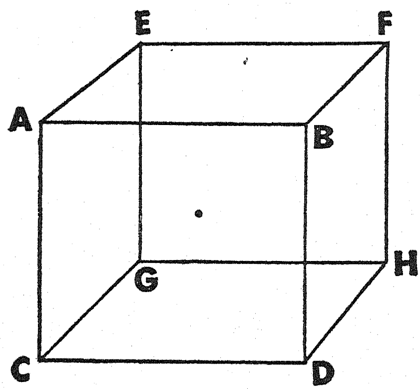


**Figure 89.—The Cube in Reversible Perspective.** (*Allport.*)

line *EG* until the plane *EFGH* appeared nearer. They were to make these alternations as rapidly as possible, and the number of alternations per minute would be the score.

In the second test with the reversible perspective, they were to fixate the dot in the center of the figure and keep the perspective from changing. The number of changes

[1] Allport, Floyd H., *Social Psychology,* Boston, Houghton Mifflin Company, 1924.

occurring in spite of the effort to fixate was used as a measure of the "constancy of attention."

In the multiplication test, the students were required to multiply horizontal rows of problems with the highest speed consistent with accuracy. For a test of free association, the subjects were asked to write as many words as possible in a given time. Inasmuch as it is possible to recall words more rapidly than one can write them, in some tests they were to recall the words as rapidly as possible but to write only every third word, and in other tests only every fourth word.

In one series of tests, the subjects worked alone in isolated rooms of the laboratory. In the other series, they worked in groups of 4 or 5, seated around the same table. An effort was made to avoid competition in these tests. The subjects were told that their results would not be compared with the results of anyone else, and that they were not to be discussed between individuals serving as subjects.

**Results of group activity.** The results indicate for the majority of the subjects a marked increase in the quantity of work done when working in a group as compared with working alone, but relatively unchanged quality of work. On the basis of these findings, Allport concluded that *social facilitation* is a factor in overt activity or the speed of movements by releasing the activities for which the individual is already prepared, but has practically no effect upon the implicit behavior. He points out that there is a greater number of distractions when one is working in a group, and the results indicate that these are more prolonged than the brief fluctuations of attention when one is working alone. Judgments of pleasantness and unpleasantness and judgments of lifted weights indicate little difference between working alone

and working together, except that when working together the subjects showed a tendency to avoid extremes which Allport calls the "attitude of social conformity."

While these experiments prevented as nearly as possible all possibility of rivalry, they might be interpreted as illustrations both of conformity and of preëminence as factors operating to influence the results. An individual is a social individual even when entirely isolated from the rest of the group. Robinson Crusoe, even before he met his man Friday, behaved as a social individual. Memories of the past, the presence of implements, weapons, and the like were social stimuli only more indirect or remote than the actual presence of his comrades had been.

The individual, when working alone in his room, is still being influenced by the work of others. The influence is greater, however, when he can see or hear the other individuals, even though he is not stimulated directly by their performances of the task. The elements of rivalry and imitation, therefore, still play an important part in his behavior. These experiments illustrate the fact that the more direct the social stimulation, the greater the influence upon the behavior of the others in the group.

**Group participation in class.** We may see some of the results of the factor of social stimulation in the organization of students in the class. Apparently, the position of the student within the class has some bearing upon the amount and quality of the work which he will do. Investigations have indicated that those in the front row do not do quite so well in scholarship as those in the second, third, and fourth rows. Those at the end of the row are slightly inferior to those nearer the middle.

The poorest position is that in the back row. This seems to hold whether the class is large or small.

It can be seen that the students in the center of the class are stimulated by students on all sides while those on the outskirts are stimulated by fewer direct sources. The attentive posture of his surrounding associates facilitates the attentive posture of the individual student. Therefore, the students within the group, being completely surrounded, possess the greatest advantage.

There are other factors, of course, besides the posture of one's immediate neighbors. The instructor should be the most important social stimulus. As he is inclined to address the class as a unit, he may look at and talk to those in the center. Those in front would receive advantage also, while those in the last row are not only isolated from the class but also are more remote from instructor-influence. Hence, there are more distractions on the sides and in the rear of most classes.

Another important factor which influences the whole group more or less equally is the standard of work done by the class as a whole. If all of the students in the class are of a high caliber, each will do better than he would if he were working in a group inferior to this class. For this reason, we find many times in a mixed class that juniors and seniors do little better than freshmen and sophomores, whereas if they were isolated in a group of their own rank, their work would be superior.

**Social attitudes.** The individual's attitude regarding various social problems, such as moral and ethical, political, religious, and similar problems, is principally the result of the social environment in which he has lived. However, we recognize the many individual variations. It would therefore be interesting if we could measure

the attitudes, beliefs, and prejudices of individuals with respect to such problems. It is to be expected that they would differ, partly on the basis of differing social groups and partly because individuals might show different degrees of discrimination and of adjustment to their social environment.

The Pressey X-O Test was designed somewhat for this purpose, and consists of three lists of words. In the first list, the subject is to cross out everything that he thinks is wrong or that a person should be blamed for, such as begging, smoking, flirting, spitting, and giggling. In the second list, he is to cross out everything about which he has ever worried, such as loneliness, work, forgetfulness, school, and blues. In the third list, he is to cross out everything he likes or is interested in, such as fortune telling, boating, beaches, mountains, and vaudeville.

Some interesting facts are brought out when the results from one thousand students of a certain college in 1923 are compared with the results from a similar group of a thousand students in the same college ten years later. On the first test, 63 per cent of the 150 items was considered wrong. On the second test, ten years later, only 51 per cent of the items was marked as wrong. Among the items for which there was the greatest decrease were smoking, begging, debt, slang, flirting, and divorce. These differences doubtless reflect the general shift in attitude of the population at large. Smoking has become more prevalent among all social groups, especially women; the attitude toward marriage, divorce, and sex problems generally is less rigid; and it is probable that the depression has affected the social attitude toward economic dependence.

In another test of social attitude, a list of such statements as, "The churches are more sympathetic with

capital than with labor," and "Dancing is harmful to the morals of young people," is presented. Each statement is to be marked +2 if it is "utterly and unqualifiedly true"; +1 if "probably true"; 0 if "undecided"; —1 if "probably false"; and —2 if "utterly and unqualifiedly false." In addition, several paragraphs representing concrete situations, followed by lists of inferences, are given. The correct inference is to be marked by the subject. A similar test of moral judgment is also included. There are variations in these forms dealing with similar concrete situations, such as socialism, the Roman Catholic Church, and political and moral problems.

## The Standardizing of Social Measurements

**The need for objective standards of measurement.** The difficulty with tests is that there is no adequate basis for evaluating the results when they have once been obtained. If we wish to determine the attitude of the student body toward football, we might call for a vote for or against the continuance of the game. But this would represent only a majority opinion for or against the practice, and would not indicate the degree of approval or disapproval. We might, in the second place, set up a series of questions indicating different degrees of approval. The difficulty here is to establish a correct gradation from complete disapproval through indifference to complete approval.

The problem is not so simple as in the case of sensory discrimination, in which we have a linear gradation in physical terms. If we wish to determine the discrimination of tones for an individual, or a group of individuals, we may select tones of the frequencies 256, 256.1, 256.2,

and so forth. These would be equal steps in the stimulus. We could then compare 256 with 256.1 and with each of the other tones in the series. We would probably find that no subject distinguished the difference between the tones 256 and 256.1. The greater the difference between the two tones, the more frequent would be the correct discriminations. In this way we could plot the frequency or discrimination for each different level.

If, however, we choose to determine the attitude toward football, war, the church, prohibition, or capitalism, we have no such linear scale. The first step, therefore, would be to devise a scale, as objective as possible, which would provide approximately equal steps in degrees of approval or disapproval. Thurstone and his associates have indicated a method which should be outstanding in the future investigation in problems of social behavior.

**Selection of items.** Let us assume, for example, that we wish to determine the attitude of certain groups toward the church. Thurstone[2] has investigated the problem in the following manner. A list of 130 statements regarding the church was prepared. These were carefully selected with the intention that they should bear as directly as possible upon beliefs with respect to the value of the church. Many items might be included which would not indicate the *degree* of this attitude. They might express phases or attitudes other than those under investigation. No attempt was made to throw out all such irrelevant statements, because the statistical technique to be used would indicate their inappropriateness and they could later be discarded.

[2] Thurstone, L. L., and Chave, E. J., *The Measurement of Attitude, a Psychophysical Method and Some Experiments with a Scale for Measuring Attitude toward the Church,* University of Chicago Press, 1929.

**Evaluating the items.** This list of 130 items was then presented to 300 individuals with the instructions that they should place them in 11 piles. The first pile was to include those statements which they believed were strongest in favor of the church. The eleventh pile was to include those statements which were believed to be strongest against the church. The middle pile (the sixth) was to contain those statements which were indifferent. The other piles would then be graded from indifferent to most favorable or most unfavorable.

When these judgments on the value of the items were completed, the cumulative distribution of each item by the 300 reviewers was made. For example, item No. 1 was not placed in any of the first 5 piles, but was placed in the sixth, or indifferent, pile by 8 per cent of the reviewers, while 17 per cent placed it in either the sixth or seventh pile; 23 per cent in the sixth, seventh, or eighth pile; 33 per cent in the ninth or lower; 52 per cent in the tenth or lower; and 100 per cent in the eleventh or a lower pile.

The next step was to determine the scale value on the basis of these 300 judgments. It should be remembered that these 300 judges were judging the *value* of the item regardless of their attitude toward the church. The scale value for each item was determined by taking the median value assigned by the whole group.

Figure 90 represents the cumulative distributions of judgments for two items. For item No. 39 the median, or the point where the curve passes the 50 per cent line, is 1.8 and is represented by the arrow. The two short vertical lines on either side of the arrow indicate the quartile range. (The lower and upper quartiles are the mid-points on either side of the median. The quartile range is frequently employed to indicate the

variability of scores with reference to the median.) Subtracting the lower quartile, 1.3, from the upper quartile, 2.6, gives a value of 1.3, which is taken as the "measure of ambiguity" of the statement.

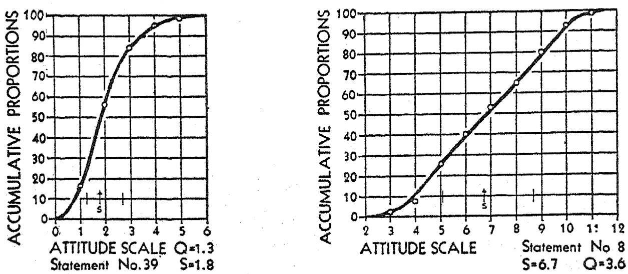


**Figure 90.—The Cumulative Distributions of Judgments for Two Items in Thurstone's Study of Attitude.**

The scale value for item No. 8 is 6.7, and the quartile range will be observed to be considerably larger than in the case of the other item, namely, 3.6. This item, therefore, is slightly unfavorable to the church, while item No. 39 is strongly in favor of the church; but item No. 8 has greater ambiguity, that is, the judgments are more widely spread. Each item was rated in this fashion.

We could, then, select from this group of items those which would make a fairly uniform linear scale, and have a low measure of ambiguity; that is, No. 8, for instance, should be omitted because it was rated by 300 judges over a wider range than item No. 39.

**Test for consistency.** We still have the problem that some of these items are more relevant to church attitude than others. This was determined when the entire list was given to the 300 judges with the instructions that they should check those items which they approved—in other words, those which expressed their own attitude.

If the scale was correct, they should not check items in extreme positions in the scale. For instance, if one item had a scale value of 10 and another a scale value of 3, it would not be expected that the same individual would check both of these. The degree of consistency was therefore measured, and those items which did not give a high degree of consistency were omitted.

**The final scale.** The result was a final selection of 45 statements of opinion which could be arranged in linear fashion with approximately equal steps from those most in favor of the church to those most opposed. This distribution is shown in Figure 91. The lower double line indicates the scale values from 0 to 11. The short, vertical lines in the upper bar represent the scale position of each of the 45 items. These items were then arranged in irregular order and presented to different groups with the instruction to check every statement that expressed their sentiment toward the church. The median of the scale values of all items checked indicates the degree of attitude of different individuals.

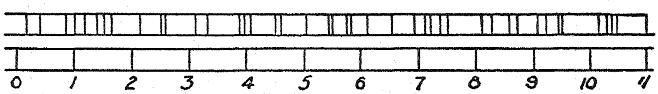


**Figure 91.—Distribution of Scale Values in the List of 45 Opinions.**

**Meaning of objectivity.** It may not be clear why this should be considered an "objective" scale. Each item has been rated by a person on the basis of his personal judgment. The *objectivity* of the scale is dependent upon the meaning of the items—how they are understood by the readers. When I say that it is only a short walk from here to the drug store, the quantitative aspect of my statement is extremely vague. If I say it is a block and a half, the statement is more definite.

A yardstick is considered an objective scale because the units of measurement are understood and verifiable. What Thurstone has done is to standardize the statements and to select those that have a definite meaning for a large number of individuals. While this scale is not so definite as a yardstick, it is a nearer approximation than any previously attempted measuring scale in this field.

**Application of the scale.** Figure 92 shows the distribution of attitude of undergraduates, graduate students, divinity students, and a selection of the Chicago Forum.

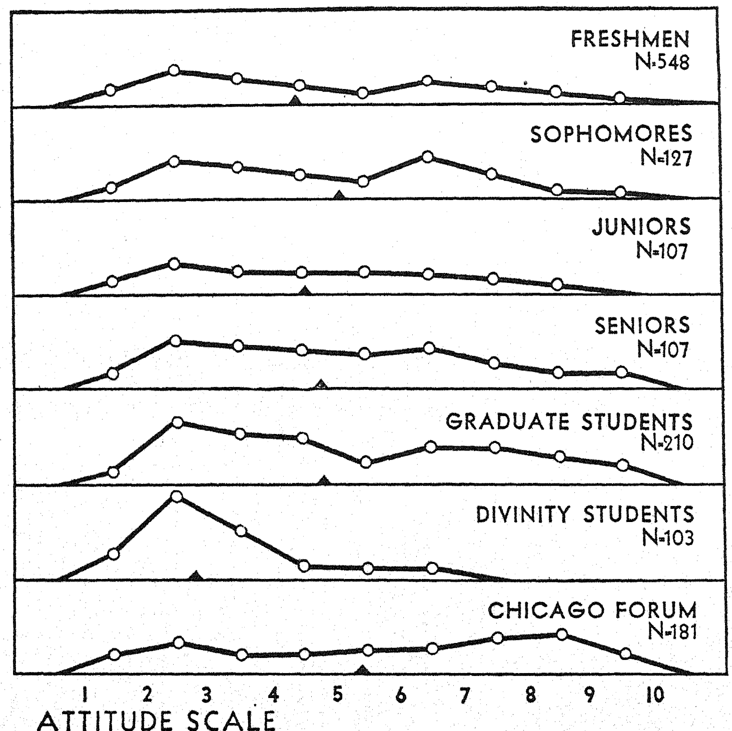


Figure 92.—The Distribution of Attitude Toward the Church of Several Social Groups. (*Thurstone.*)

The arrow indicates a mean score for each group. It will be seen that the mean attitude of each group in the undergraduate and graduate levels varies only slightly, while the divinity students indicate an attitude very favorable to the church. The Chicago Forum displays the lowest attitude or least favorable attitude toward the church, with a wide spread from most favorable to most unfavorable.

To summarize this method, the important factors are:

1. A scale of values as objective as possible is obtained by statistical analysis of the judgments of 300 judges.

2. Items which do not fit closely to this scale but include other attitudes not specifically related to the importance of the church are eliminated in a similar manner as irrelevant.

3. Items which are ambiguous are also eliminated.

4. Thus there is constructed a scale which is linear; that is, each item bears directly upon the particular problem, and each item has a specific value in the scale determined by the combined judgments of 300 judges.

### Questions for Review

**1.** What is the evidence which indicates that social facilitation is a factor in overt activity? What effect does this type of facilitation have on behavior?

**2.** Cite some examples from your own experience which show the effect of the presence or absence of other individuals. Is this effect always the same, i.e., one of facilitation?

**3.** What are some of the techniques used in the determination of social attitudes? What are some of the results of these procedures?

**4.** Describe Thurstone's technique for the measurement of attitudes. What are some of the criticisms of this technique? What results have been obtained with these tests?

## Reference

Thurstone, L. L., "The Measurement of Opinion," in *Readings in Experimental Psychology,* edited by W. L. Valentine, New York, Harper and Brothers, 1931, pp. 588–599.

## CHAPTER XXXII

# Personality

**Social adaptability.** We usually think of personality as expressive of an individual's effectiveness in social relations. We often say that Mr. $X$ is intelligent but lacks personality. By this we mean that we recognize his ability, but that he does not get along well with his associates, or that he is not forceful in impressing or influencing others. Occasionally, we mean that he is a social misfit or is not generally liked.

In a more general way, we judge personality by the social adjustments that the individual makes. Does he make friends easily, or is he timid in the presence of strangers? Is he sympathetic and considerate of the feelings of others? Can he be trusted: is he dependable at all times? Is he aggressive and confident of his own position and ability, or is he inclined to wait for others to take the initiative? Does he possess a fund of useful knowledge? How does he meet difficult situations, such as an economic depression, disappointment, slander, and similar events? We could multiply almost indefinitely the number of questions expressive of phases of personality.

These questions all lead to two fundamental questions: To what extent does he adjust to his environment and to what extent is he master of the situation? Both are important, for we must make adjustments, must make concessions to those situations which we cannot modify,

and we should be able to master or control our environment to some extent. We may therefore define *personality* as *the individual's characteristic reactions to social stimuli and his adaptation to the social features of his environment.*[1]

**The admirable personality.** Select for consideration a person whom you very much admire as a man. What are the characteristics which make him outstanding? He may possess, first of all, a good physique. He is what you would call a good-looking specimen of Homo Sapiens. While stature is a desirable trait, other traits are so important that you may admire another man even though he is a cripple. You say that his personality glows through his deformity.

Your acquaintance with this man has brought to light that he has what you call a "philosophy of life." In other words, he possesses clearly defined motives, recognizes his own abilities and limitations, possesses courage in the face of difficulties, recognizes the good qualities as well as the defects in those who oppose him, possesses poise in situations where others exhibit emotion, and solves his problems when he comes to them. He also *lives* his religious and moral ideals. His habits of living are satisfactory both from the standpoint of his personal welfare and as viewed from the social point of view.

The contrasted personalities of two former students may serve to make the point clear. *A* was a man of medium stature, but of some athletic ability. He was of more than average intelligence. He vacillated between several objectives, and never stuck to one occupation for long. When he failed to attain a goal, he

[1] Allport, F. H., *Social Psychology*, Boston, Houghton Mifflin Company, 1924, p. 101.

was inclined to find the fault in others. This excuse for his defeats led him to attempt to obstruct others in order to gain his own ends. When he finally settled into one line of work and was successful within the limits of his ability and early training, he still continued to get his greatest pleasure in falsifying and criticizing his associates.

*B* was a man of less rugged physique and possibly of slightly less intelligence in the sense that he learned more slowly in the same field of science. But, from the first, he possessed one strong motive—to make the most of every opportunity. He recognized his physical handicaps and so planned his work and rest that he could get the most out of life. Though poor, he accepted the situation. When an expected scholarship award which he needed to defray expenses failed at the last moment to materialize, he accepted the situation graciously though he might easily have assumed that a personal grudge was involved.

**Importance of habits.** When we attempt to describe the personality of an individual, what we actually do is to investigate all the habits which this individual possesses. For practical purposes, we may divide these habits into three classes: (1) explicit habits, such as the ability to handle tools, acts of skill, reactions to specific situations which call for explicit behavior; (2) emotional habits, such as proneness to become excited or disorganized in situations of danger, embarrassment in the presence of others, grudges, and prejudices; and (3) implicit behavior patterns, which include thinking, imagination, and memory. It must be recognized, of course, that these three classes are not entirely separate so far as the individual's behavior is concerned. In all situations, he undoubtedly behaves in a way that may be classified

under each of these heads. Thus, let us suppose that he is driving an automobile. He is attending to his driving, and is considerate of his own safety and that of others—which we may classify largely as implicit behavior. At the same time, he manipulates the controls skillfully—which involves the explicit habits. He may be irritated because of the poor performance of the car or he may be pleased with the total situation—which involves the emotional habits.

Individuals will differ very largely in how they handle a car. You have perhaps ridden with a friend who is a continual source of embarrassment to you because of his impolite attitude toward pedestrians and other motorists, or you may have ridden with a driver who seems to take great chances and yet handles his car skillfully and is at all times considerate of others. The important fact in personality development is the proper integration of or balance between habits. Occasionally, you meet an individual who seems to lack this total integration. He is skillful, energetic, and intelligent, but seems to lack all sympathy with others; that is, he is what you call the purely cold intellectual. Again, you see another individual who is carried away by his emotions, showing that a strong sentiment may dominate him at the expense of common sense.

**Principles of personality development.** (1) *New habits constantly needed.* It is necessary, therefore, that the individual develop habits which make possible the proper adjustment in his social environment. The young infant is adequately adjusted if he is sufficiently skilled in the feeding response, cries when he is hungry or in pain, and sleeps fairly regularly. At eight months he has acquired a few other habits, such as handling small objects roughly and reacting to the facial expres-

sions of others in a vague sort of way. At the age of three years there are still other habits that he has acquired, such as walking, talking, obeying commands, adjustment to emotional situations of a mild character, the control of temper tantrums, and some recognition of the rights of others. For the adult, a great many habits are necessary in order that he may make adjustments to constantly changing social situations—such as independence in the care of himself, ability to make decisions, and the proper balance between sentiments and intellectual and physical types of behavior.

(2) *Elimination of inadequate habits.* When an individual is a child, he should behave as a child and speak as a child; but when he becomes a man, he must put aside childish habits. It is necessary for a child of three years to depend upon his parents and other adults. It is expected that he will cry when injured and that he will have other habits which we label merely childhood traits. For the adult to display these habits—in other words, to be dependent upon others, to be afraid of strangers, and to maintain a childish attitude toward the problems of life—is for him to display an inadequate personality. Sometimes a fond parent overlooks this fact in the training of a child. Little Johnny at fourteen years is the baby of the family, is watched over by his mother, is told when to wash his face, is told to put on his coat when it is cold, and in many other ways is kept dependent upon her as he grows older. When it is necessary for him to leave home, he finds himself unfitted to cope with the everyday situations of the adult.

(3) *Habit interference.* The establishment at an early age of habits which will interfere with the development of adequate habits as the individual grows older should be avoided. For example, a little child was al-

ways fed in his own room until he was five years old. This appeared at the time to be an ideal arrangement. The child was happy, ate regularly, and made no resistance to the proper diet. However, when the child was brought to the table with adults, he was forced into a new situation for which he had no ready response. He failed to eat properly, rejected food that ordinarily he enjoyed, and was a general disturbance to the adults. The habit of eating alone interfered with the new habit of eating with older people.

(4) *Recognition of actual situations.* Too frequently we neglect to recognize that the child must live in a particular environment in spite of the fact that it may not seem ideal. Boys must meet boys who are rough and who do many things which we consider undesirable. It is therefore necessary that he learn to meet these situations rather than that he be protected from them. It is necessary to learn how to get along with people as they really are rather than as we would like to believe they are.

As a further elaboration of these four principles, it is only necessary to point out some of the consequences of their violation. Many very young children are encouraged in the use of an excess of "baby talk"; they are taught to do cute things, to show off; and they are humored or pampered for the satisfaction of the parent. Later these foolish habits have to be corrected, often at the expense of considerable effort on the part of both the parent and the child.

In many cases these childhood habits persist well into adult life. The pampered child may become the arrogant, overbearing adult who never respects the feelings and rights of others. The child who has been dominated in the home, forced to obey at all times without regard

to his own independence or without proper consideration of the fact that he must learn to make his own choice at times, may become the submissive, docile adult who is dependent upon others for the direction of his activities.

A child of 2 years cannot dress himself, but he can be taught to make the task easier. At a later period, he can bathe and dress himself without assistance, though it is not so good a job and takes longer than for an adult. Still later, he can buy his own neckties and other wearing apparel, even though his selections are an outrage to his parents' sensitivities. He is learning to be independent and to get along in his social world. The child who does not have the opportunity to learn to take care of himself, to fight and to play with others of his own age and thus to learn to make his own social adjustments develops the weak, peculiar, or otherwise defective personality.

As the individual comes in contact with his social world, he must give and take. He must learn to make social adjustments first in the home. If the situation there provides the opportunity for him to learn the limits of his own freedom, the rights of others in the larger social environment will be easy for him to recognize. We have shown in the discussion of motivation (Chapter XII) that the types of attitudes and ideals the individual develops are the outgrowth of all the habits that he has developed in reaction to situations as they have arisen.

To suffer pain or disappointment, to overcome obstacles, to gain satisfaction in the socially acceptable activities, to meet situations which are within the limits of his present development or stage of maturity, these are all a part of the foundation of the strong personality.

**Personality traits.** When we attempt to analyze the personality of an individual, we find it convenient to think of personality as composed of an aggregate of traits or specific characteristics. We say that the individual is intelligent, gets along well with his associates, is a hard worker, honest, is somewhat reserved in the presence of strangers, and so forth. The fact that the listing of such traits is convenient in the analysis of personality very easily leads to the assumption that there are a certain number of fundamental traits which are common to all individuals and inherent in human nature. As a matter of fact, there may be as many traits as we find it necessary or convenient to note in our study.

**Traits as habit systems.** We may define a personality trait as any group of habits which we choose to consider as belonging to one pattern. For example, we may consider honesty as a trait of personality. We may mean that the individual will not steal, will not cheat, and will not lie. We mean that he has well-defined habits with respect to situations demanding honesty. In the same manner we may speak of habit systems of leadership, friendliness, cheerfulness, persistence, and courage. It will readily be seen that some of these so-called "traits" overlap, that habits which are involved in one are also found in another trait. This merely serves to emphasize the fact that our classification of traits is arbitrary and based upon their social significance in our study.

**Traits not universal.** When we have made a list of personality traits, or habit systems, a careful examination of each trait will show that they are not generalized abstractions which fit all situations. For example, leadership is a well-recognized trait; but a person may

be a leader in one situation and not in another. Leadership may mean that the individual possessing that trait has developed habits of taking the initiative in the more directly social situations. He is a leader of men, a good executive or commander; he does not hesitate to express his opinions or to act on them.

On the other hand, leadership may be in the realm of the more implicit reactions which we have defined as "thinking." The individual in this case has developed habits of analyzing situations and of reaching new conclusions irrespective of the opinions prevailing in his social group. He is less restrained by the traditions or habits of thought of the era in which he lives.

### Methods of Studying Personality

At present we may list three methods of investigating personality: (1) the case history or biographical method, which is purely qualitative; (2) the rating method, which attempts to state qualitative judgments in more objective terms; and (3) the experimental method, which seeks quantitative measurements of specific traits.

**The biographical method.** This method is widely used. It may be in the form of a short interview in an employment office for the purpose of selection of employees, or it may be used by student advisers. The more thorough investigations are made by the psychiatrist in the investigation of the previous history of a patient suffering a neurosis.

The chief purpose in this method is to make a thorough study of the early life of the individual, the physical and social environment, and the habits, attitudes, and experiences that affect him in later life. In other words,

the investigator seeks to interpret the individual's interests, hobbies, likes, and dislikes in the light of his childhood experiences. Attempts have been made to apply this method also to the study of historic personages, authors, artists, and political leaders.

**Man-to-man rating method.** When we have selected a group of traits which for any specific purpose seems adequate, it is necessary for us to have some standard of judgment for determining the degree to which an individual possesses these traits. One of the methods employed is known as the *man-to-man* rating.

The individual who is to do the rating first selects for one of the traits a man of his acquaintance who possesses this trait in the highest degree. He also selects a man who possesses this trait in the least degree of any one of his acquaintances, and a man who possesses this trait in such a degree as to fall as nearly as possible midway between the first two men. He likewise chooses a man who falls as nearly as possible between the first and third, and another who falls between the third and fifth. He thus has a standard based upon five men who are, in his own judgment, equally spaced as to the degree in which they possess this trait.

The same procedure is followed for each of the other traits. The men representing these traits might not be the same in each case. It is also to be presumed that the rater is intimately acquainted with the individual he is about to rate, or that he has some means of determining the degree to which the subject possesses these traits. If he is rating several individuals, he should rate each one on one trait, then proceed to rate each on the second trait, and so forth.

**The graphic rating method.** Another method which is frequently employed is the *graphic rating* method

| | | | | | |
|---|---|---|---|---|---|
| 1. *Manual Habits:* Ability to understand by manipulation (laboratory methods). | Superior Manual Habits | Understands Readily Through Manipulation | Ordinary | All Thumbs | |
| 2. *Verbal Habits:* Ability to understand and use written and spoken language (lecture and reading methods). | Writes and Speaks Lucidly and Clearly | Ordinary | Often Confused | Writes and Speaks Unclearly | |
| 3. *Maturity:* Developed adult habits. Freedom from childhood habits and viewpoint. | Adult | Adolescent | Childlike | Infantile | |
| 4. *Accuracy:* Precision, attention to details, intellectual honesty. | Precise | Painstaking | Careless | Very Unreliable | |
| 5. *Industry:* Application, zeal for the task, capacity for sustained effort, perseverance. | Always Busy | Industrious | Indifferent | Tires of a Task Easily | |

**Figure 93.—Graphic Rating Scale.** The degree a trait is judged to be possessed is indicated by a check mark on the horizontal line.

(Figure 93). The blank used provides a line for each trait, usually showing the degrees of that trait. The rater is to make a check on the line to indicate his judgment with reference to the degree that this individual possesses the trait. If he decides that the individual is above ordinary in manual habits but does not understand readily through manipulation, the check is made somewhere between these two terms. This procedure is followed for each of the traits involved. It is assumed that each rater will interpret the scale in the same way.

**Halo effect.** By rating each individual upon one trait before rating on the next trait, we are able partially to avoid the error of the personal bias or prejudice. Usually, however, we do find our judgment warped by our general impression of the individual. If he is high in scholarship, we are likely to consider him high in comprehension, application, or dependability. If he is particularly low in one of these traits, we are inclined to rate him low in the others.

It is generally found that greater accuracy is obtained if the number of traits to be employed is small. Five to 7 traits are more satisfactory than 20. However, in some instances where a thorough examination of personality is required, a much longer list which is more detailed and searching in its purpose may be employed.

One of the most helpful lists of traits is that devised by F. L. Wells.[2] This personal inventory is divided into 14 general classes, and under each are several specific items. For example, the items under "self-assertion" are the following list of questions:

[2] Wells, F. L., "Personality and Hygiene," *Psych. Rev.*, 1914, Vol. XXI, pp. 293–333.

How much effort to shape surroundings?
How independent of the opinions of others?
How much tendency to assume leadership?
How ambitious in material things?
How able to bear up under difficulties and misfortunes?
How able to face crises?
What inclination to face danger?

**The experimental method.** In the assumption that the rating method generally proves inaccurate and is particularly subjective in the sense that one must rely entirely on the opinion of the rater, efforts have been made to develop experimental techniques which would give quantitative measurements of the degree of the trait possessed. As most of the traits usually considered are extremely complex systems of habits, the difficulty usually rests upon the fact that the trait is not clearly defined.

One experiment [3] is suggestive of some of the attempts that have been made. The experimenters attempted to measure aggressiveness by the association method and by steadiness of eye fixation during an interview. The association test employed as stimuli words which might call out associations which would indicate whether the individual was inclined to meet social situations positively or negatively. In the eye fixation test, the individual, during a part of the experiment, was required to look fixedly at the eyes of the experimenter while an assistant counted the number of times that he glanced away.

As a check upon the adequacy of the experiment, each subject was rated by those who knew him best. The

[3] Moore, H. T., and Gilliland, A. R., "The Measurement of Aggressiveness," *Jour. App. Psych.*, 1921, Vol. V, pp. 97–118.

success of the experiment, therefore, must be decided upon the basis of the adequacy or accuracy of the rating method used.

**The self-rating method.** Another test method which yields results that may be treated quantitatively is really a self-rating technique. The subject is asked to state what adjustments he would make in each of a large number of situations. By the use of this method an extended study of the traits of ascendence and submission has been made.[4] The aim was to present in verbal form a fair sampling of social situations which the subjects might be expected to meet in daily life; for example: "Are you embarrassed if you have greeted a stranger whom you have mistaken for an acquaintance?" "At a reception or tea, do you seek to meet the important person present?" The replies were scored as plus (ascendent) or minus (submissive). The total score of each subject was the algebraic sum of the scores of the separate items.

Figure 94 gives the distribution of the total scores of 400 college men. It will be seen that a few possessed the trait of ascendence to a marked degree while a few were markedly submissive. A large percentage of the subjects showed only a slight ascendent tendency. None of the subjects was entirely consistent in his replies. There was considerable variation in most cases, according to the situation. This is what would be expected. The dominant or ascendent person does not maintain this attitude under all conditions.

**Rebuilding your personality.** The college student is often interested in what he can do to improve his personality. It must be recognized that if habits are so

[4] Allport, G. W., "A Test for Ascendence-Submission," *Jour. Abn. and Soc. Psych.*, 1928, Vol. XXIII, pp. 118–136.

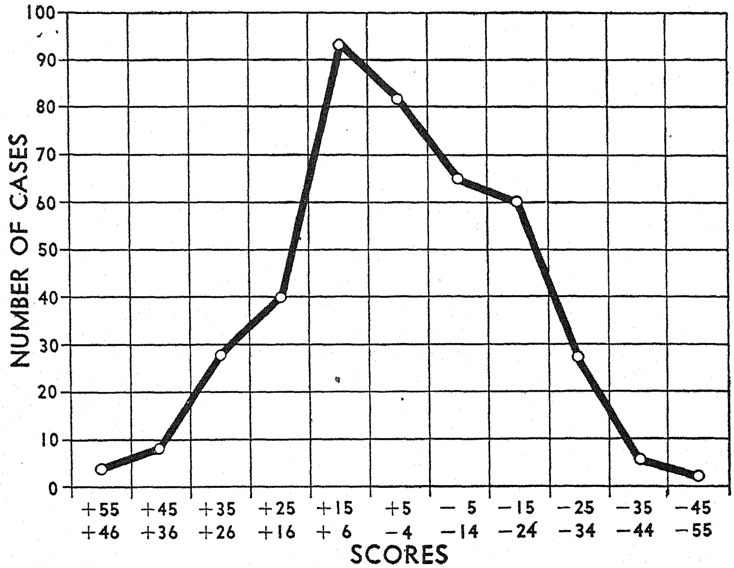


Figure 94.—Distribution of Scores in a Test of Ascendence and Submission. (*G. W. Allport.*)

important to the development of personality, it is useless to expect that you can remake your personality overnight. Frequently a student assumes that the mere fact that he takes a course in psychology ought to be all that is necessary for his formation of the correct personality. Knowledge alone does not change our habits. It is only as we are willing to undergo the slow process of reorganizing and of developing new habits through practice that we can make any noticeable change in our personality.

In Chapter XIII we pointed out that the best method of making adjustments when we meet an obstruction of a motive is to analyze the situation, including the environment and our potentialities, and then to make the best of our possibilities. This principle may be ex-

tended to the more general facts of personality. As you meet varying situations in college and in your general social environment, you can observe many times what your own inadequacies are, and you may then set about developing habits which will enable you to make the correct adjustments.

It may be that you will find that you are easily embarrassed in the presence of others. Then, instead of withdrawing from the social group, practice meeting the demands of the group, and you will soon acquire a feeling of freedom in public places. If you find that you have inadequate habits of study, that you are inclined to give up easily or fritter away your time, the only remedy for your deficiency is persistent endeavor in application, which brings its own rewards. If you are dependent upon others, practice in making your own decisions, even though they are not so good as those someone could make for you, will develop the habit of independence. In the course of four years, a great transformation may be made; but it must be remembered that you have already spent twenty years in the formation of habits, and these cannot be set aside easily.

## Abnormalities of Personality

When we consider that personality is the expression of the total integration of the habits which the individual has acquired, we realize the simple corollary of this fact: that many abnormalities of the personality are due to defective habits or to the failure to develop habits adequate to meet some situations. As to who are abnormal, we frequently say that we are all abnormal in the sense that we do not possess perfect adjustments in all situa-

tions. From another viewpoint, however, we may say that the abnormal are those who deviate considerably from the norm, or the usual.

There are a great variety of deficiencies, which may be divided into two specific classes: (1) those due to structural defects, and (2) those which are primarily the result of poor habits. It is not our purpose to describe in detail the results of structural defects further than to say that brain injuries or deterioration of the brain due to disease or old age frequently results in a variety of phenomena ranging from mild defects to definite insanity. The more distinctly psychological deficiencies are more important for our consideration.

**Ineffective personalities.** It has been clearly shown in the preceding discussion that it is of fundamental importance that the individual develop new habits to meet the new demands made upon him as he grows older, and that he give up his childish methods. Some people fail to do this. We say that the young lady is intelligent but immature. What has actually occurred is that she has been protected in the home or has developed a habit of dependence and of thinking in childish terms. Hence, she is not so developed for her age as her associates. One student displayed this type of personality to a marked degree. She revealed in an interview that during her first year in high school she did not like to study, and therefore avoided courses that were difficult and managed to get through with as little work as possible. On entering college, she failed in all of her work and displayed mannerisms and the general appearance of a girl at the ninth-grade level.

Closely related to childishness is a type of selfishness or egotism. The individual of this type has learned not

tended to the more general facts of personality. As you meet varying situations in college and in your general social environment, you can observe many times what your own inadequacies are, and you may then set about developing habits which will enable you to make the correct adjustments.

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only to depend upon others, but to neglect the rights and feelings of others even when it brings great hardship upon those he ought to help.

**Heredity and training.** It is frequently assumed that the abnormal individual has inherited defects which make him different from others. While there are a great many individual variations in personality as a result of inheritance, too great emphasis cannot be placed upon the fact that children are treated differently even in the same home. The mere fact that they have grown up in the same family, that they have the same parents and brothers and sisters, does not mean that they have lived in the same environment. The parents take toward one child an attitude that is different from their attitude toward another partly because they have arrived at different periods in the parents' lives. Financial and other circumstances have varied, and hence one child is viewed differently from another. Sometimes there are different attitudes toward boys and girls. Sometimes a difference may exist in the treatment of two boys or two girls. One child is given a constant expression of confidence. He is made to feel that what he attempts he can do; while the other is constantly told directly or indirectly that he must be protected, and hence develops an entirely different personality.

**Oddities of personality.** In Chapter XIII, we pointed out that the individual may develop peculiarities as a result of interference with his dominant motives. He may develop a feeling of inferiority. He may compensate for this feeling by blustering, and may find fault with others. Many other peculiarities may develop in a similar way. Thus, in one case, a boy was reared by cultured, pious parents in a part of the city where his only playmates would be rowdies if he were allowed to

associate with them. Consequently he was reared very carefully at home and never allowed to play with the other boys. When he went away to school at the age of 14, he found that he was incapable of making adjustments to the other boys. He could not play their games and he could not speak their language. As a result, he emphasized the traits which he could master and they could not or traits in which they were not interested. He developed a peculiar form of walking with his arms held rigidly slightly in front of his body. He insisted that this was the only correct posture in walking.

Some oddities are merely the carrying over from childhood of habits which appear peculiar in the adult or in the new situation. The farmer boy may still be a farmer after living in the city several years. He simply has failed to develop the city manners as a substitute for country manners.

**Nervousness.** We frequently hear that a person is very nervous. In fact, many people seem to pride themselves on possessing a nervous temperament. They really possess a low threshold of stimulation; that is, it requires only a weak stimulus to evoke a response in them, or they have developed no adequate habits of inhibition and consequently respond on the slightest provocation to all types of stimuli. While there are physical factors involved in such traits, they are also frequently a matter of personal habits. One student exhibited a high degree of nervousness in the laboratory. If a rule fell off the table, she would be as startled as though she had heard a pistol shot. If the instructor walked past the door of the room in which she was working, she would exhibit the same startled behavior. However, when she took part in an experiment which was designed to test resistance to emotion-provoking stimuli,

her performance was as good as that of any other student. When interviewed, she admitted that she had learned as a child that she could get anything she wanted by being nervous, and that in college she had used the same method to get permission from the dean of women to be excused from her classes because she needed extra sleep. As a matter of fact, she was out late nights and enjoyed sleeping through the forenoon.

**Personality versus environment.** We have tried to show that an adequate personality is one that makes adequate social adjustments in a normal society. However, the environment itself fluctuates. Society makes greater demands upon the individual at one time than at others. College life is more severe than home life. Periods of great economic depression, prosperity, drought, and war call upon the individual's behavior resources in different ways.

One of the most common factors in the abnormal development of personality is the period of adolescence. Here we have a conflict between the biological factors of the changing organism and the childhood habits on the one hand and the demands of civilized society on the other. Most young people, both boys and girls, possess inadequate information and inadequate habits to meet the new situations without emotional disturbance. Consequently, boys are ugly and incorrigible in their behavior, and girls are silly and equally incompetent.

This period is frequently considered the "storm and stress period" of youth, but that the social environment is equally responsible for this situation is illustrated by the fact that in many primitive societies such situations do not exist. Meade[5] points out that in Samoa, where

[5] Meade, Margaret, *Coming of Age in Samoa,* New York, William Morrow and Company, 1928.

the children witness all of life's processes, including birth and death, they grow gradually from childhood into adulthood without experiencing the emotional shock that is so prevalent in our own society.

In our society, the child comes to adolescence as to an entirely new situation. The young man passes from the routine of office or shop and a peaceful society into the war camp. Our fluctuations in economic conditions make adequate adjustment as difficult at one extreme as at the other. Therefore, it is necessary that we devise new and more satisfactory methods for the development of personality. Aristotle[6] postulated that the educated man was the good man, but he meant by "education" what we mean by the "integrated personality."

## Questions for Review

1. What must we know about an individual before we can make an adequate statement regarding his personality? What methods may be used to obtain this information?

2. What principles are to be followed in the development of an adequate personality? Give some specific examples to illustrate these principles.

3. Think of some examples of inadequate personalities among your own acquaintances. In what respects is the behavior of these individuals deficient?

4. Examine carefully your own behavior in a number of different situations. What may you conclude regarding the adequacy of your own adjustment? In what respects may it be improved? How will you set about accomplishing these improvements?

5. Criticize the point of view which holds that a personality trait is a unitary, indivisible aspect of behavior which is not only unmodifiable during an individual's life, but which is passed on by him to his offspring.

[6] *Ethics.*

6. Contrast the various methods of investigating and measuring personality traits. Which of these methods will yield the most reliable quantifiable data?

7. What are some specific uses to which the results of reliable personality measurements may be put?

8. From radio, magazines, and other sources, select some examples of popular "quack" personality measuring techniques. Criticize these procedures.

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